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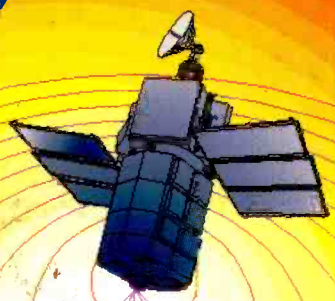
BROADCAST engineering

1993 Technology Update



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- Interactive TV and Cable
- Selecting PBX systems

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- Power line protection
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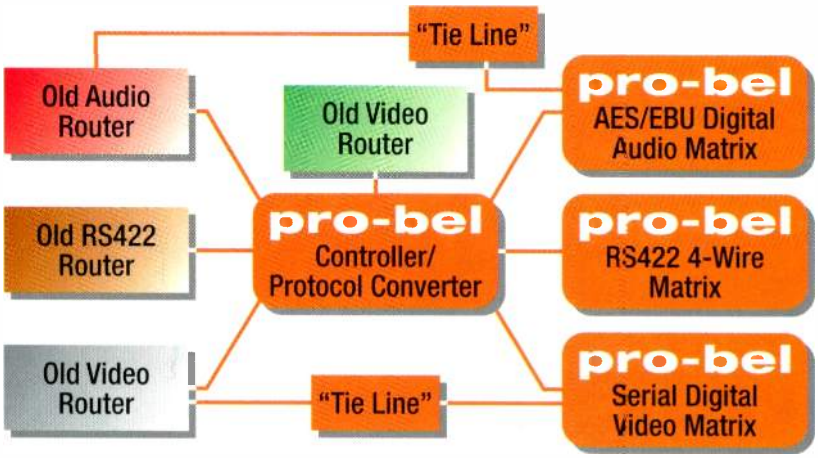

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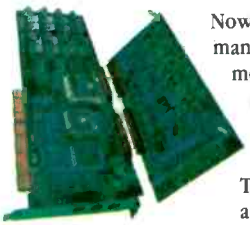

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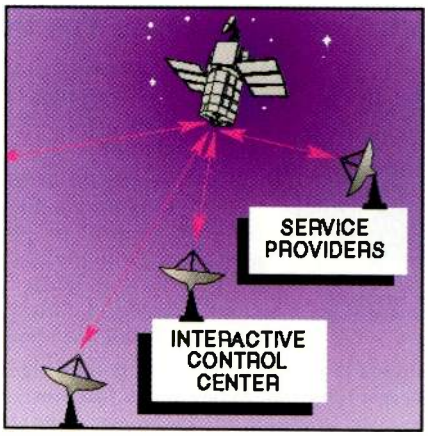

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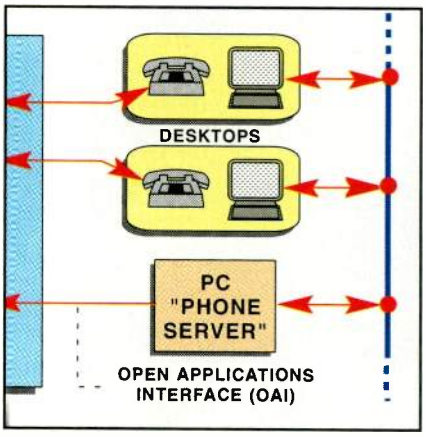

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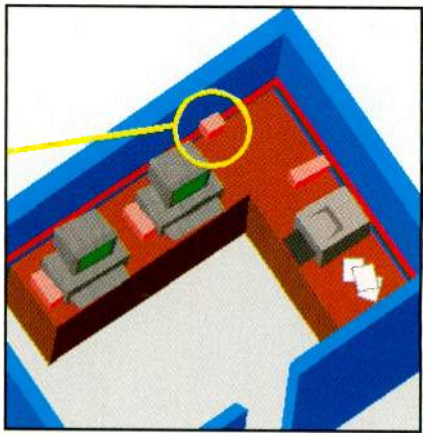

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1993 TECHNOLOGY UPDATE:

*This year closes with a bang as **BE** reviews the many exciting events that occurred this year. From HDTV to DAB, to industry news, we will take you back for more than just a nostalgic glimpse at the year's past events. We will look forward to how these events and new technologies will affect our industry and our future as we step into 1994.*

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News

By Dawn Hightower, senior associate editor

Sony to provide DBS consumer receiving equipment

In support of its efforts to build North America's first high-power direct broadcast satellite (DBS) service, DirecTv, Inc., a unit of GM Hughes Electronics, has tapped Sony Corporation to supply DSS Digital Satellite System home receiving equipment. DSS equipment will be capable of receiving programming from DirecTv and United States Satellite Broadcasting, Inc. (USSB), a DBS licensee and owner of capacity on the first of two Hughes-built high-power satellites scheduled to become operational in 1994.

DSS is a 3-component receiving system that consists of an 18-inch satellite dish, a compact digital receiver and a remote control. Through DirecTv, DSS-equipped households in the United States and Canada will have access to approximately 150 channels of programming.

DSS features include digital transmission to the home; an on-screen program guide; remote-control operation of all system functions; CD-quality stereo sound with multichannel capacity; theft-resistant scrambling and security of the TV signals; and compatibility with existing and advanced TV formats, including 16:9 widescreen and HDTV.

Sony will manufacture and distribute DSS equipment under licensing arrangements with DirecTv, Thomson Consumer Electronics and News Datacom. Thomson is the developer of the system's digital compression technology and will be the initial DSS supplier under its RCA brand name. News Datacom will provide the conditional access and encryption system. Sony receivers will be introduced at a retail price of $700 in early 1994. Sony basic and feature-added terminals will become available after Thomson's one millionth unit is sold or when its 18-month exclusive manufacturing period expires.

Sony Electronic's Business and Professional Products Group is developing and installing broadcast systems and equipment for the DirecTv Broadcast Center in Castle Rock, CO. Sony Pictures Entertainment has agreed to provide entertainment programming for the new venture.

SBE membership selects new president

The Society of Broadcast Engineers (SBE) has elected Chuck Kelly Jr. as president. Kelly is director of international sales for Broadcast Electronics, Quincy, IL.

Kelly's 1-year term began during the annual meeting Sept. 30, held in conjunction with the SBE Convention in Miami Beach. He most recently served as SBE vice president and has been a member since 1980. Kelly replaces Richard Farquhar, who will serve as immediate past president.

Other newly elected SBE officers are Terry Baun, vice president (principal of Criterion Broadcast Services in Milwaukee); Keith Kintner, secretary (engineer at KLCS-TV in Los Angeles); and Bob Goza, treasurer (engineer at KMOV-TV in St. Louis).

SBE members serve on joint engineering conference committee

SBE president Chuck Kelly Jr. has announced that five members will serve on a joint engineering conference committee with the National Association of Broadcasters (NAB). The committee will be responsible for planning education sessions for the 1994 conference in Los Angeles, Oct. 12-15.

Committee members are Marvin Born, vice president of engineering, WBNS stations, Columbus, OH; David Carr, chief engineer, KHOU-TV, Houston; Dane Ericksen, senior engineer, Hammett & Edison, San Francisco; Douglas Garlinger, director of engineering, LeSea Broadcasting, Noblesville, IN; and Jerry Whitaker, technical writer, Beaverton, OR.

The Engineering Conference is for engineers in radio, television, cable, post-production and other related fields.

The event will feature the conferences of three other industry organizations: the Radio and Television News Directors Association (RTNDA), the Society of Motion Picture and Television Engineers (SMPTE) and the National Association of Broadcasters Radio Show.

Interactive TV to be launched in Portland

Interactive Systems, Inc. (ISI) has announced plans to launch its international interactive TV system in the United States. On Dec. 13, ISI and KGW-TV began a 2-month field test of the end-to-end system. On April 18, 1994, the test will be expanded into a 500-1,000 home market on all local Portland TV stations.

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Steve Epstein, *Technical Editor*
Dawn Hightower, *Senior Associate Editor*
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TECHNICAL CONSULTANTS
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Eric Neil Angevine, *Broadcast Acoustics*
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CORRESPONDENCE
Editorial and Advertising: 9800 Metcalf, Overland Park, KS 66212-2215. Telephone: 913-341-1300; Editorial fax: 913-967-1905. Advertising fax: 913-967-1904. Subscriber customer service: 800-441-0294

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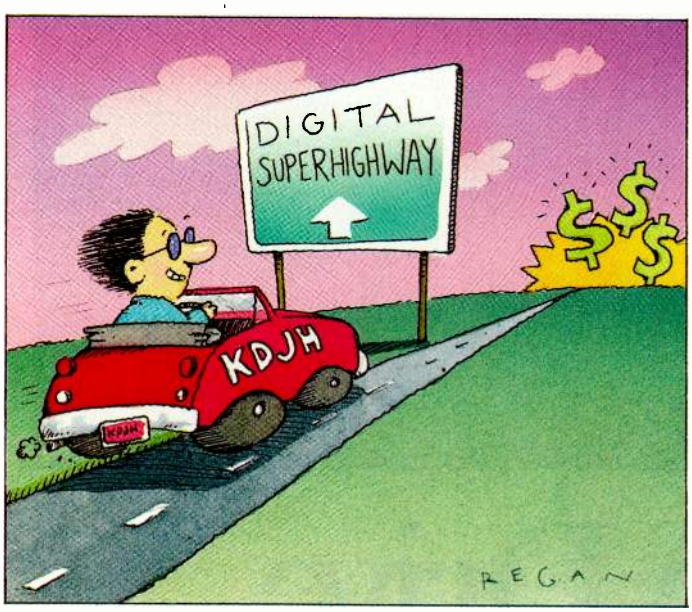
Editorial

Look for the opportunities

"In business, the competition will bite you if you keep running; if you stand still, they will swallow you." – William S. Knudsen

I'm tired of seeing headlines about the imminent death of broadcasting. With claims of 500 channels, satellite-delivered, pay-per-view and video-on-demand services, the reader is left with the impression that the broadcasting industry is about to become a museum piece. Many print reporters don't realize that broadcasters will remain an important part of the entertainment mix for many years to come.

Two areas about broadcasting receive inaccurate coverage by the print media. The first is expressed by their enamored view of the computer and cable industries. By relying on well-versed PR departments of these two industries for information, the American public is being led to believe that TV broadcasters (and their own TV sets) are about to become as obsolete as the dinosaur.



The second type of misleading press coverage comes from our own industry. With association press releases coming out about how bad the financial condition of our stations are, it's no wonder that the financial markets view our properties with question. If broadcasting is as sick as many would have us believe, then how did FOX develop a successful fourth network in such a short time? If we're on our death bed, why is there so much interest in developing a *fifth* network?

Much of the blame for the public's and Wall Street's view of broadcasting is its own fault. The broadcast industry has adopted a "woe is me" position. It expects the government to ride in on the white horse of regulation to stifle the competition and save its collective butt.

Forget it broadcasters. Wake up and smell the coffee. If you want to be successful, you have to make it on your own. Stations and networks cannot expect Congress or anyone else to save them from their mistakes, laziness or a reluctance to compete.

Look for opportunities instead of spending so much energy blaming others and trying to stifle the competition.

The key is to re-examine your business. Broadcasters who see themselves as merely an entertainment pipe from studio to home are making a big mistake. That pipe can be easily replaced with cable, fiber or satellite. What can't be replaced by those mediums is the knowledge of programming, local community involvement and service that broadcasters have always provided.

Station managers and engineers who take the time to explore the options will find that opportunity exists and more will develop soon for expanded services.

For example, with technology from WavePhore, it's possible for TV stations to transmit hidden data along with the video signal. The cost to the broadcaster is practically zero! Radio stations also can transmit data and voice services on SCA channels. One new paging service is being rolled out by Seiko (the watch people). Now you can receive pages on a wrist watch. Who will provide the transmission signals? FM radio stations, of course.

The new digital highway everyone is talking about is neither as imminent or revolutionary as many portray. Nor does it eliminate the role and opportunity for broadcasters. Whether you as a local station successfully ride that road to the profits that lie ahead depends on you and the innovation that made American broadcasting the success it is today.

Brad Dick

Brad Dick, editor

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FCC Update

Cable ownership limits

By Harry C. Martin and Andrew S. Kersting

The FCC has issued an order implementing the ownership limitation provisions of the 1992 Cable Act by prescribing national subscriber limits. It also limits the number of channels that can be occupied on a cable system by a video programmer in which the cable operator has an attributable interest.

The agency established a 30% limit on the number of homes passed nationwide that any one entity can reach through cable systems in which such entity has an attributable interest. The FCC will permit ownership of additional cable systems, up to 35% of homes passed nationwide, provided that 5% of the homes are passed by minority-controlled cable systems. These horizontal ownership limits have been held unconstitutional by a lower court, and will not become effective unless that decision is overturned.

With respect to vertical ownership limits, the FCC adopted a 40% limit on the number of channels that can be occupied on a vertically integrated cable system by video programmers in which the cable operator has an attributable interest. Carriage of up to two additional channels or 5% will be permitted, provided such video programming services are minority-controlled. The channel occupancy limits will apply only up to 75 channels; channel capacity beyond that will not be subject to these vertical restrictions. The channel occupancy limits won't apply to local or regional programming services.

Limits on commercial time on TV stations

The FCC has initiated an inquiry seeking comment on whether the public interest would be served by putting limits on the amount of commercial matter broadcast by TV stations.

In a separate proceeding, the FCC found that home shopping stations have been serving the public interest and qualify for must-carry status. Nevertheless, the Cable Act directed the agency to determine whether stations that are predominantly used for the transmission of sales presentations or program-length commercials serve the public interest. Accordingly, the FCC has requested comments on whether, and in what specific manner, an excess of commercial programming disserves the public, and whether the FCC should re-examine the basic assumptions of its 1984 TV Deregulation Order. The agency also seeks comments concerning whether some measure other than public acceptance should be used to define an "excess" of commercial programming, and what it should be.

The FCC also is seeking comments on whether the adoption of limits is warranted; whether the FCC should enact a strict rule establishing specific limits; and the form that any regulation should take. For example, whether limits should be based on the amount of commercial programming per hour, thereby precluding the broadcast of program-length commercials or whether they should be based on a longer period of time that would permit extended sales presentations.

Comments also are being sought on how the FCC should ensure compliance with commercial limits, such as whether TV stations should be required to maintain station logs of commercial programming or whether certification of compliance would be sufficient. Finally, comments are being sought on the First Amendment implications of any proposed limitations on commercial programming.

New PCS established

The FCC authorized new personal communications services (PCS) in the 2GHz technologies bands. The agency allocated 160MHz for PCS, which constitutes 120MHz for licensed PCS services and 40MHz for unlicensed PCS devices.

The Budget Reconciliation Act of 1993 requires the FCC to begin licensing PCS through the auction process within 270 days of enactment. The FCC has requested comments on a variety of proposals designed to meet the statutory requirement that small businesses, rural telephone companies and businesses owned by women and minorities be given an opportunity to participate in the bidding process. The agency tentatively concluded it would set aside one 20MHz block of spectrum to be licensed on a "Basic Trading Area" basis for these groups.

The FCC proposed that qualifying bidders competing for licenses in this block be allowed to pay their winning bid over time and that their qualifying deposit be less than that required by non-designated groups competing for other blocks of spectrum.The agency requested comment concerning how tax certificates might be used to facilitate deployment of PCS by minority or female licensees.

Deadline for PCB transformer removal

Certain types of polychlorinated biphenyls (PCB) transformers were to have been removed from service or retrofilled to a lower PCB concentration by Oct. 1. EPA regulations permit lower-voltage network PCB transformers (those with a secondary voltage of less than 480V) to be used in or around commercial buildings for the rest of their useful life only if they are equipped with electrical protections to prevent ruptures caused by high current faults. If these protections were not installed before Oct. 1, 1990, the transformer should have been removed from service by Oct. 1, 1993.

These rules apply only if the transformer is within 30m of a commercial building. If the transformer is located in a secluded area and access is restricted to station staff, the facility it not considered commercial. However, PCB transformers in non-commercial facilities are subject to EPA use, storage and marking requirements. They also must be registered with the local fire authorities and the owner of the building where they are located.

Date line

On Feb. 1, 1994, annual ownership reports (or ownership certifications) are due for all radio and TV stations licensed to communities in the following states and territories: Arkansas, Kansas, Mississippi, Nebraska, New Jersey, New York and Oklahoma. New Jersey and New York TV stations and Wyoming LPTVs must file their renewals by Feb. 1.

Martin and Kersting are attorneys with Reddy, Begley & Martin, Washington, DC.

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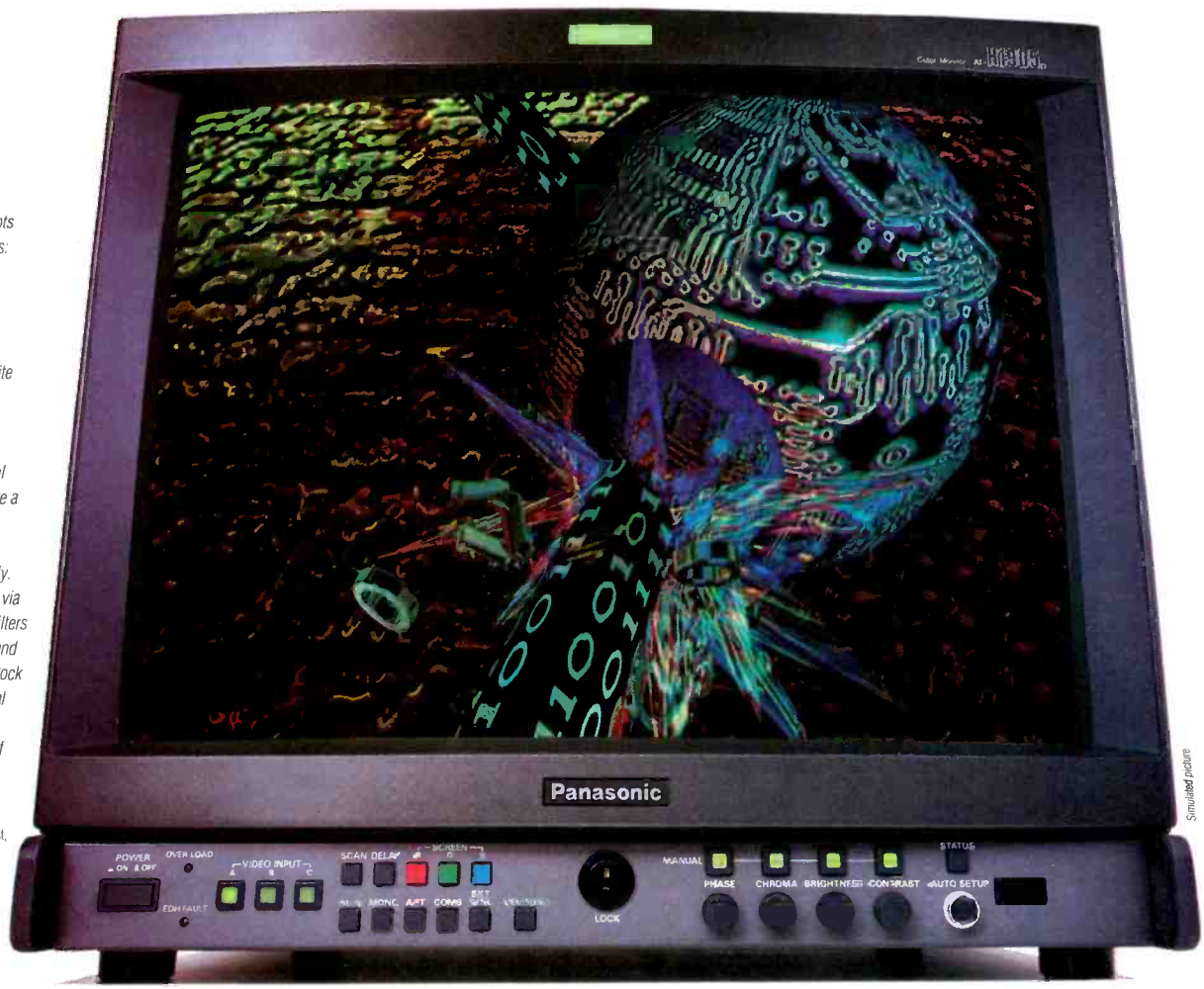

Simulated picture

Part 12

Strictly TV

Strictly HDTV

Looking toward the future

By Curtis Chan

During the past year there has been considerable activity centered on the establishment of a formal terrestrial broadcasting standard. One highlight was the formation of the Grand Alliance. In 1994, the alliance will work to reduce the contributions of the various proponents to a single specification acceptable to ACATS.

For those who followed the news at Montreux, the concept of a Tres Grande Alliance was spearheaded by Michel Pelchat, the French founder of the Association for the Television of the Future (ATF), and ACATS chairman Richard Wiley. The ATF plans to have an international conference in Paris. Representatives from the broadcasting, cable, satellite, telephone and electronic industries will seek an agreement to define a common path toward television's future.

In other news, the alliance hoped to have all the system parameters defined for the audio and scanning formats completed by this fall, with hardware available by the summer of 1994. Similarly, an MPEG-2 standard draft also was scheduled for approval this past November.

Interoperability

Although not new, interoperability has resurfaced as one of the hot issues in moving digital television closer to the world of computer graphics. Washington policymakers, the Grand Alliance and Advisory Committee members are focusing on the near-term goal of completing a single standard specification. Outside forces are offering recommendations toward evolving the standard to coexist with the computer graphics world.

In recent months, the computer industry has been vocal about square pixels and progressive scan. Opponents cite that although advantageous for video manipulation in TV programming postproduction, square pixels and progressive scan are hardly essential. The computer industry is threatening to start its own standardization process if the FCC and ACATS fail to respond in an appropriate manner. Regardless of what stance is taken, other institutions are taking up the interoperability initiative.

Recently, MIT's researchers have been investigating methods to make digital datastreams more flexible to televisions and computers receiving them. MIT's goal is to develop a transmitting scheme involving techniques that approximate those used for the description of computer graphics data.

The alliance will work to reduce the contributions of various proponents to a single specification.

In this technique, digital compression algorithms would identify the regions of a picture that might have to be treated differently by an encoder. For instance, the backgrounds and foregrounds of scenes could be segmented from each other. Audio information could be integrated with the video bits rather than being sent as a separate audio bitstream.

Michael Bove, MIT's associate professor of media arts and sciences, noted that the receivers would decode data describing scenes and not individual pixels. The resultant transmission would resemble a computer graphics database, and would allow data to be viewed in different ways by different screens.

The process would have several distinct benefits. The datastream would be able to tell the receiver how pictures should be rendered for different screens, such as in the case of automatic panning and scanning of widescreen pictures for display on 4:3 sets. Bove said that the integration of digital and audio data could bring new levels of accuracy to sound reproduction.

Bove added that the new signal would require chips with more memory because screens would be composed of new and stored information. Once encoders can integrate different pieces of data during a longer period of time, then it's time to focus on the decoding end.

Earlier this year, testifying before the House Telecommunications and Finance Subcommittee, Media Lab director Nicholas Negroponte urged the alliance to concentrate on data transport and to drop portions of the standard relating to image representation. This relates to the work of MIT's Media Lab, so that the MPEG standard might carry a syntax closer to the Media Lab approach for describing digital signals.

Audio stand-off

The alliance once again is trying to resolve the issue of whether to select a system based on the testing performed in July or to put the systems though another round of testing. The deadlock came about because of a deadline on audio system selection. Executives from Philips Labs expected to offer grounds for pushing back the audio testing deadline to conduct additional testing on the system proponents. The attempt met with resistance from the other audio pundits, who had said they would not participate in the audio testing if the Alliance Technical Oversight Group didn't reaffirm the need for more testing; a decision the group was unable to reach.

The lack of participation from the other proponents prevented Philips from conducting additional tests on its proposed Musicam system. The move concerned Philips executives to the point of suggesting the company pull out of the alliance if further testing was not performed. This is despite the fact that during the initial round of testing at Lucasfilm this summer, the Philips Multichannel Musicam system scored low on some tests while its competition, the Dolby AC-3 and MIT's-AC, did fairly well. However, participants in the Expert Group maintained that another round of tests similar to those performed would not yield useful information.

Stay tuned for more updates on decisions that will affect the establishment of a terrestrial broadcasting standard. ■

Chan is principal of Chan and Associates, a marketing consulting service for audio, broadcast and post-production, Fullerton, CA.

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Re: radio

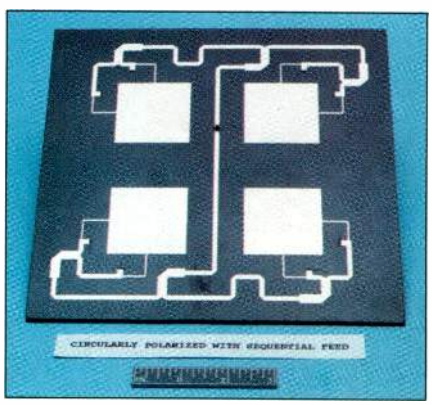
Merging traffic ahead for DAB?

By Skip Pizzi, technical editor

The road to DAB in the United States continues to proceed down two separate paths. Upcoming along one route is a format testing process conducted by the EIA and NRSC. (See "DAB: Radio's Rising Star," August 1993.) The other course runs through the FCC, where a Notice of Proposed Rulemaking in General Docket No. 90-357 is currently pending for S-band DBS radio. (See "re: Radio," March 1993.)

The Docket 90-357 NPRM and the EIA/NRSC processes run on non-intersecting parallel paths, yet they are inevitably contiguous at their end points. The four remaining Docket 90-357 DBS proponents are seeking licenses first and hardware/formats later. This follows a DBS tradition where orbital slots are an operator's primary asset. Meanwhile at the EIA/NRSC, five other proponents seek to develop a hardware/format system first and then submit it to the FCC for its blessing as a standard, to be applied to licensees later. The Docket 90-357 DBS players therefore see themselves primarily as *service providers,* while the EIA/NRSC deliberations involve mostly *hardware manufacturers.*

To date, the only potential intersection between the two proceedings involves the willingness of some Docket 90-357 DBS players to adopt as their hardware/format component whatever emerges as a standard from the EIA/NRSC deliberations.



Prototype DBS-R antenna built by JPL for NASA/VOA tests. Differing feed line lengths and off-center locus of antenna's feed probe point (black dot) provide physical and electrical phase sequencing for optimum CP performance across a wide bandwidth. Antenna size is approximately eight inches square. (Courtesy of JPL.)

NASA/VOA developments

Perhaps the most significant DAB milestone in recent months — and a hint of future delivery systems' possible design — was provided by successful tests of the S-band DBS format under development by NASA and the Voice of America (VOA). It is the only exclusively satellite-based system among those under consideration in the EIA/NRSC process. Although intended as an eventual replacement for international short-wave broadcasting, the system may have wider influence.

NASA/VOA has set up a contract with CalTech's Jet Propulsion Laboratory (JPL, a frequent NASA collaborator) to develop components of the system. Between $2-$3 million of U.S. government funds have been allocated for R&D, but NASA/VOA have no plans to complete the system's development. At some point, the system design will be turned over to interested equipment manufacturers. The system's modular design allows it to be used for different applications and in different parts of the world.

Unique among DBS radio systems is NASA/VOA's requirement for reliable reception *indoors.* This demands a specialized antenna design for which system developers specify a minimum gain requirement of 11dBi. Outdoor reception will only require an omni whip antenna.

The antenna used for the system's indoor tests is a small, flat plate design incorporating four square receptor patches for circular polarization (CP) on a printed microstrip array. (See photo.) Two variations have been developed, one of which uses a *sequential feed* technique to optimize CP over a wide bandwidth, at the expense of some gain (approximately 2dB less than a conventional design of the same size). An important practical advantage of the sequential design is its resulting wider *beamwidth,* making orientation less critical.

This implies that reasonable gain can be delivered for a substantial range of satellite elevations. This allows the antenna to remain in a fixed horizontal position and adequately pick up signals from satellites that are 50° or more above the horizon. Alternatively, some variable orientation might be provided by incorporating the antenna into a hinged back panel on a portable receiver, for example. Spatial diversity between two such panels might also be used on high-end designs. JPL designers also expect that the current 8-inch (20cm) square panel size can be reduced to approximately six inches (15cm) square by moving the microstrip feedlines to a separate layer under the patch elements.

Unique among DBS radio systems is NASA/VOA's requirements for reliable reception indoors.

What's next?

Although not much movement is expected soon on Docket 90-357, EIA/NRSC proceedings should be quite active, given their completion target of late 1994. Some nagging questions remain: Will the EIA/NRSC process result in a *single* standard, or will several formats be recommended as "best of class" for the various types (in-band, new band and DBS) of systems under evaluation?

Another issue of interest will be comparison of the EIA's VHF band multipath measurements (see "re: Radio," September 1993) with the results of EIA/NRSC proponent USA Digital's own recent tests of same. Internationally, the BR (Bureau de Radiocommunication, the former CCIR) also is expected to announce recommended standards for DAB in late 1994. Overall, the new year could be a pivotal time for DAB, in which divergent developments may at last converge.

Editor's note: Thanks to John Huang and Nasser Golshan at JPL, and Don Messer at VOA, for their assistance in preparing this article. ■

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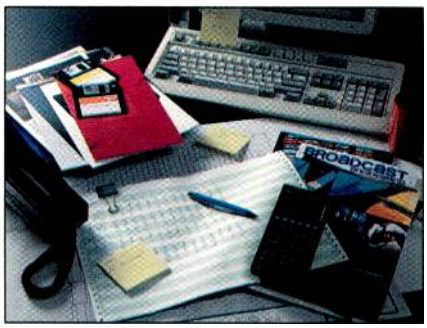
Management for Engineers

Communicating engineering needs



By Judith E.A. Perkinson

Broadcast Engineering and the "Management for Engineers" column recently solicited questions from our readers. Many reflected a concern that engineering needs were not being heard by general management. We came across these comments:

> "I try to tell the GM about our engineering needs, but it's like talking to a brick wall."

> "We need new equipment, but as long as I break my back keeping the old stuff going, I can't make anyone believe we need new equipment. Sometimes, I feel like I should sluff off and maybe then they would realize we have a problem."

How is it that some engineers manage to get the equipment they need? Why do some stations consistently budget for the capital expenditures required in the engineering department while others never do?

The answers to these questions are simple. Individual engineers have found a way to make their engineering needs heard. They have bridged the gap between the engineering and the non-engineering departments.

Be responsible for communication

This is the most essential step. You have the need, so *you* are responsible.

1. *Talking is not communicating.* Just because you've told someone something doesn't mean you've communicated. Taking responsibility for communication means you send the message, and you also check to make sure it was received.
2. *Hearing is not understanding.* Once you know that the other person has heard what you're saying, the next step is to make sure the person has understood.

The general manager is responsible for the station, which means he should be responsible for knowing what the engineering department needs. However, "should" is not going to get your engineering problems and needs communicated. Once you understand that *you* are responsible for communication, you are one step closer to having your needs determined.

Perkinson is a senior member of the Calumet Group Inc., Hammond, IN.

Why aren't you heard?

There are numerous reasons why you may not be heard. Frustration may lead you to assume that the general manager doesn't care. However, it is more probable that the GM doesn't understand.

Your GM may not understand the needs of the engineering department for several reasons. The more familiar you are with these reasons, the more able you will be able to bridge the communications gap.

1. *Language.* Every discipline has its own vocabulary. The more technical the discipline, the less likely anyone outside the discipline will understand the terminology. Most general managers do not have an engineering background, so they may not be comfortable with the terminology.

It's up to you to close the communications gap between engineering and the rest of the station.

2. *Technology.* In addition to the language barrier, there is the technical knowledge necessary to understand the implications of what is being communicated. As an engineer, you understand the consequences when you explain a situation relative to the malfunctioning of a specific component of your equipment. That's because you understand the technology. Therefore, telling your GM what is wrong may not constitute a problem to him.
3. *Problem ownership.* Because of a lack of understanding, many non-engineering personnel view technical problems as belonging to engineering. Make the non-engineering staff understand how they affect your ability to solve the problem, what they need to do to make it possible for you to solve it, and/or what you need to solve the problem. Without that ownership, you may continue to feel you don't have the support you need.
4. *Admitting ignorance.* Most non-engineering personnel do not feel comfortable with engineering issues. The lack of knowledge, the lack of fluency with the terminology and the resulting feelings of inadequacy can make most people uncomfortable. When people are uncomfortable, they may not be cooperative or helpful. This discomfort with engineering-related issues is the greatest source of resistance that most engineers face.

Getting past the problems

It is up to you to close the communication gap between engineering and the rest of the station. Four key elements can help you build your communications bridge:

- *Vocabulary.* Learn how to turn "engineer talk" into terms that non-engineers understand. Pay attention to department buzzwords, and don't use them when you are communicating outside your department. Make a list of common engineering terms. Translate them into English and use them when you're speaking to people outside your department.
- *Education.* Without being condescending, educate the non-engineering personnel who make decisions that affect engineering. Take them under your wing and make them comfortable with the technology. Help them to understand the problems you face.
- *Prospective.* Point out the effect that your engineering issues have on the functioning of the station. New equipment could mean better audio and or video quality, less risk of being off the air, reduction in ongoing costs and many other non-engineering issues. This helps translate engineering problems into station problems that non-engineers can relate and respond to.
- *Trust and credibility.* When you effectively communicate, you build credibility. With credibility comes trust. With trust and credibility comes cooperation.

Learning to be heard properly is not easy. However, once you take responsibility for your speaking, a new world of communicating will be open to you. ■

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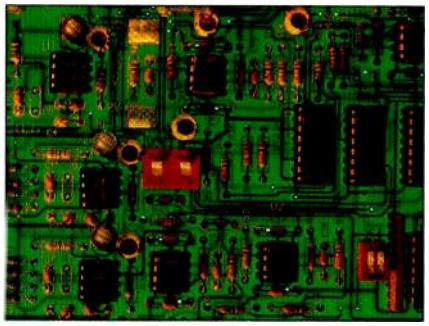
Part 2

Circuits

Digital audio via telco

Dial-up and other flexible services



By Jack Kelly

In Part 1, telco T-1 service was noted as a preferred point-to-point service for broadcasters because of its cost-effectiveness, versatility, reliability and quality. Several associated services based on T-1 can make it even more flexible for audio transport:

• *DACS* (Digital Access Cross-Connect System): A T-1 circuit's 1.5Mbit/s data can have each of its 64kbit/s DS0 slots sent to different destinations. (See "Circuits," November 1993.) This is a good service for stations, groups or LMA partners to use for interconnecting multiple sites. WATS, 800, off-premises extension (OPX), foreign exchange access (FX) and Switched-56 lines (referred to later) into your station can be combined over the same T-1 line, making even more effective use of the T-1 service.

OPX allows a broadcaster's PBX system to use slots on the T-1 to cross-connect an off-site location's telephone into the system so that it operates as an in-house extension. FX allows the PBX to route calls into the local phone network at the *other* end of a T-1 path. If the T-1 runs to a distant city, FX service allows long-distance toll charges to that area to be avoided.

• *DACS-CCR* (DACS-Customer-Controlled Reconfiguration): This service combines DACS with the ability to dynamically reconfigure each 64k segment at the station, with no telco intervention. This can be useful if a station is in a large metropolitan area and has an active news or programming department.

• *56k DDS:* This refers to dedicated (non-switched) 56kbit/s service. Note that this is not technically a T-1 service, but a derivative. The service can provide data-reduced 7.5kHz mono audio for communication or STL backup.

High-quality audio on a dial-up basis

A sister service to dedicated 56k DDS is *Switched-56* service, one of three available dial-up digital services available to broadcasters. It is available almost everywhere in the contiguous United States and is applicable to sports, special-event and remote talk show backhauls.

In addition to Switched-56 services, the *Integrated Services Digital Network* (ISDN) is being deployed by telcos to transport higher-bandwidth applications on a dial-up basis, including broadcast audio. *Basic rate ISDN* provides 128kbit/s, which is sufficient for high-quality mono (or medium-quality stereo) data-reduced audio transmission on a real-time, dial-up basis. *Primary rate ISDN* provides 1.5Mbit/s (equivalent to a full T-1 circuit), which could be used for full CD-quality digital audio transmission in real time without data reduction, on a dial-up basis.

Interface equipment

Each of the services mentioned requires a different type of interface to its respective network. Among switched services, Switched-56 interfaces are called *data service units* (DSUs), and ISDN interfaces are called *terminal adapters* (TAs). All these devices are generally referred to as *terminal equipment*, and they may be purchased by the broadcaster or leased from a telco.

For any real-time audio transmission employing data reduction, an additional digital audio converter and data reduction coder/decoder (codec) is required. In some cases, the codec function and the interface function are combined into a single device.

Another interface device available to broadcasters is called an *inverse multiplexer.* This can be used to combine multiple digital telco lines between two locations into a single, wider bandwidth (higher data rate) path. For example, three ISDN circuits can be combined to provide dial-up 384kbit/s service, allowing high-quality data-reduced stereo audio transmission. (See Figure 1.)

Clearly, the broadcast marketplace has become more competitive, and inventive use of new capabilities must be part of every engineer's strategy. Developing a command of new transmission systems can provide a significant contribution to the continued viability of any broadcast operation. ■

Kelly is vice president of marketing at Intraplex, Westford, MA.

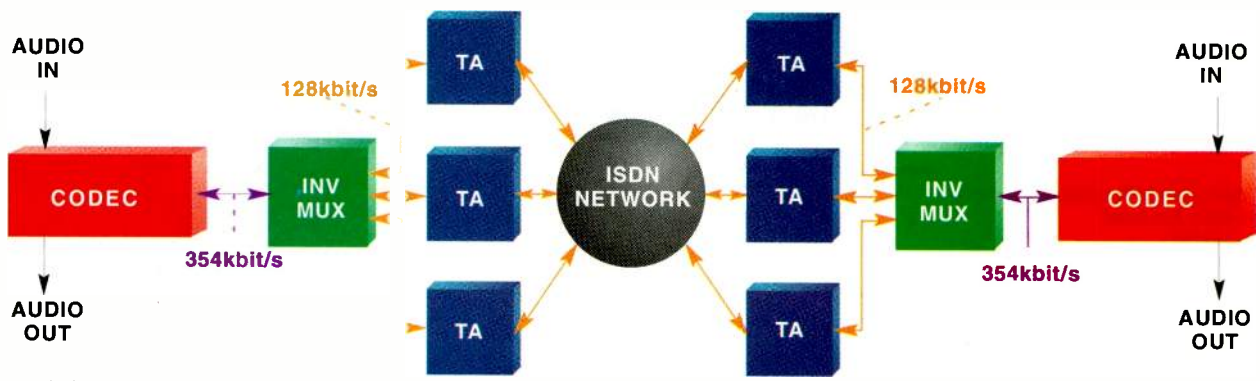


Figure 1. *An example of switched digital service used for high-fidelity audio transmission. Here, three ISDN circuits are used with inverse multiplexers to provide a bidirectional 384kbit/s path.*

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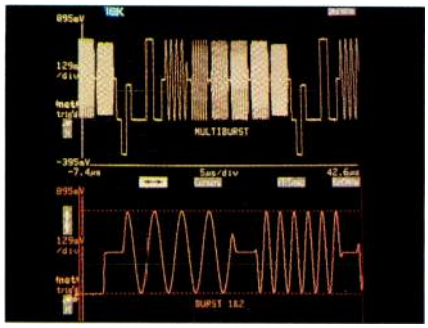
Part 2

Troubleshooting

Understanding crosstalk



Crosstalk and impedance

By M. Raymond Jason

The archetypal crosstalk system is shown in Figure 1. Within this system, there are four source/load impedance pairs: the explicit source and load impedances of the two channels, and the implicit source and load impedances of the crosstalk signals that couple from each channel to the other.

The source impedance of a crosstalk channel is defined by the capacitive, inductive and resistive coupling between the driven and undriven channels, represented in Figure 1 by the dashed resistor. The load impedance of a crosstalk channel is the parallel combination of the undriven channel's own source and load impedances: $R_{parallel} = R_{source} * R_{load}/(R_{source} + R_{load})$. For simplicity of description, assume that just one of the two "real" channels is driven, and the other channel is undriven. The latter will be the "victim" of the first channel's crosstalk.

Voltage transmission vs. power matching

Wherever cable runs are short enough to prevent *transmission line effects* (for audio, this includes runs of less than 1,000-2,000 feet), you're better off using a 60Ω to 70Ω source impedance and a 10kΩ or higher load impedance (the so-called *voltage transmission* or *bridging condition*), rather than the power-matching 600Ω source and load impedances that the audio industry inherited from its telco origins.

A primary benefit of voltage transmission is the ability to *fan-out* a signal: a +4dBu 60Ω source driving 10 100kΩ inputs produces +3.95dBu at each of those inputs, all without the overhead of distribution amplifiers. Savings occur in equipment costs, lower power and cooling requirements. Fan-out is not possible with power matching. Of course, distribution amplifiers may be desirable for increased interchannel isolation in either case.

Another key benefit of voltage transmission is improved frequency response. The inherent capacitance of shielded, twisted-pair cable becomes a low-pass filter when combined with a source impedance. High-end rolloffs accumulate through an audio chain — it takes just a few minor rolloffs in series to create a major one.

Although it would seem that high-frequency effects could be eliminated by using a 0Ω source impedance, this is not true. When the source impedance drops below the characteristic impedance of an interconnect cable, there is a danger of high frequency *peaking*. Typical shielded, twisted-pair cable has a characteristic impedance of approximately 70Ω, and this is what defines the optimum source impedance.

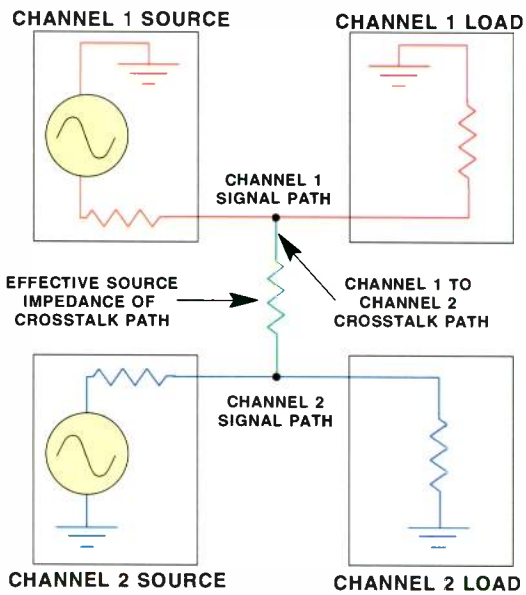


Figure 1. *Typical crosstalk situation showing implicit signal path between "driven" and "victim" channels.*

The characteristic impedance of a shielded, twisted-pair cable is determined by the following:

1. Measuring its conductor-to-conductor capacitance per unit length, with the conductors open.
2. Measuring its inductance per unit length with the conductors shorted together at both ends. Expressing capacitance C and inductance L in units of farads and henrys, the characteristic impedance $Z_0 = \sqrt{L/C}$, in ohms.

A hidden benefit

Another, perhaps lesser known, benefit of voltage transmission is reduced crosstalk. Philip Giddings pointed out in his book "Audio System Design and Installation" that electrical field crosstalk, the more common type (see "Troubleshooting" November 1993), depends on the impedance of the victim circuit. This impedance forms a voltage divider with the effective source impedance of the crosstalk signal.

For example, if at 5kHz the effective crosstalk source impedance is 50kΩ and the victim circuit impedance is 60Ω to ground, the loss (in dB) from the driven to the undriven circuit will be 20log[60/(50,000 + 60)], or approximately -58dB. With a power-matched 600Ω circuit (which has a combined impedance to ground of 300Ω) the loss is only about -44dB.

Voltage transmission equals less crosstalk

The crosstalk performance of voltage transmission therefore beats that of power matching by approximately 14dB. A difference this large is usually seen only when comparing the top-of-the-line to the bottom for any given type of audio equipment.

If you haven't replaced your power-matched interconnections, perhaps the benefits of reduced crosstalk will tip the balance for you in favor of voltage transmission. If you already voltage-source your system or are about to perform a voltage-transmission-based installation, make sure that the cable is compatible with your equipment's output impedances. Low-capacitance cable, which might appear attractive for its reduced high-frequency roll-off, achieves its specification at the expense of higher inductance, raising the characteristic impedance — and optimum source impedance — to as high as 150Ω ■

Jason is an electronics engineer at National Public Radio, Washington, DC.

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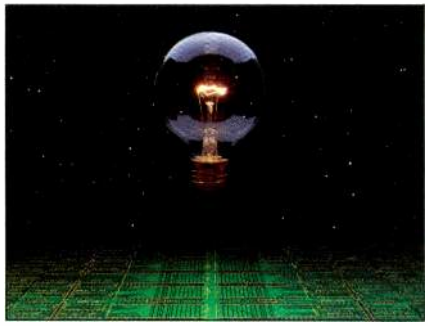
Circle (12) on Reply Card

Technology News

PC relief



By Curtis Chan

Last month's feature, "Troubleshooting PC-Based Equipment," discussed the trials and tribulations of troubleshooting PCs. However, it didn't mention that most PCs are based upon the decade-old bus architecture known as the ISA bus. This bus hinders today's fast SCSI peripherals and CPUs.

Despite relief from workaround solutions, including graphics accelerator boards and RAM caches, the 8MHz 16-bit bus is a bottleneck. There are trends toward implementing VESA local bus and EISA bus systems, but neither are fully accepted by the PC community. Today's 32-bit CPUs spend much time waiting for graphics and other high bandwidth peripherals to send and receive data over the ISA bus.

A solution to this problem is the local bus. Several varieties and their common criteria include:

- high bandwidth.
- processor independence.
- complete specification of parameters.
- ease of implementation.
- cost-effectiveness.

The PCI local bus

The Peripheral Connect Interface (PCI) local bus was designed with these goals in mind and allows for interface over successive generations of microprocessors. This is accomplished by isolating peripherals and plug-ins from changes in CPU and system architecture evolution. Although the PCI local bus is aimed at lowering today's price-performance point, it's also designed for future cross-platform migration. As an example, PCI is currently being implemented in the X86, Alpha AXP and Power PC processor families.

Total performance solution

Unlike local bus schemes that only speed graphics, the PCI local bus increases performance across networks, disk drives, full-motion video applications, graphics and high-speed peripherals, such as LANs, mass storage devices and back-up/external drives.

As a reference, at 33MHz the synchronous PCI bus transfers 32-bit data at up to 132Mbyte/s. Graphics and I/O interfaces have different requirements than CPU-to-memory interfaces. PCI, being optimized for graphics and I/O, makes use of linear bursts for reads and writes. Because of this, faster clock speeds show little gain over 33MHz, but add additional CPU cycles or wait states because of the time required to perform address decodes. Increasing the clock to the I/O devices also increases design complexity and cost. With PCI, the CPU can run at 33MHz+ while running zero wait state posted writes to the buffers in the chip sets. The data then is bursted in a linear sequence over the bus to the graphics co-processor or I/O device, increasing overall system performance.

An enabling standard for today and tomorrow

As industries move toward an interactive high bandwidth environment, the PCI local bus seems certain to be a contender. Within specification 2.0, a transparent 64-bit extension of the 32-bit data and address buses has been defined. The 64-bit extension can effectively double the bus bandwidth to 264Mbyte/s and offers forward and backward compatibility for 32-bit and 64-bit PCI local bus peripherals. Because the bus is optimized for I/O functions and is processor-independent, it can operate concurrent with the processor/memory subsystem while allowing a scaled architecture toward future and multiple processor architectures.

A PCI expansion card can be used in any PCI-based system, including PCI-based i486, PCI Pentium, PCI Dec Alpha or even a PCI-based Mac PowerPC. The PCI specification also defines the use of 5VDC and 3.3VDC. This is ideal for today's low-power mobile environment, and the imminent move from 5VDC to 3.3VDC in the desktop environment. This ultimately will save money and reduce board real-estate, power consumption and power requirements.

Far-reaching benefits for universal plug-in

One problem in today's so-called standardized environment is the frustration of meticulously analyzing hardware and software DMA/IRQ/address requirements, setting the jumpers and DIP switches to the appropriate settings and plugging in a new add-in card, only to have the system crash. This exercise is further complicated when using a third-party memory manager to load TSRs high.

The PCI architecture represents a breakthrough in auto-configuration setups.

The solution can be time-consuming and necessitates a trial-and-error approach in reconfiguring the various jumpers, DIP switch settings and software macro edits. The PCI architecture represents a breakthrough in auto-configuration setups. Configuration registers are specified for PCI components and add-in cards. A system with the configuration software embedded automatically configures the PCI add-in cards at power-on.

The PCI local bus was designed to eliminate expansion card compatibility problems. All PCI expansion cards will fit in ISA, EISA or microchannel-based systems. Hardware shipped with the cards allows modification to accommodate the various system form factors.

Because a single PCI card works in all three system types, add-in card vendors have a single design point – increasing product availability while reducing maintenance costs and the confusion of matching the expansion card to the differing system requirements. Vendors can focus on competitive performance issues differentiating their products and not worry about bus compatibility issues.

PCI's processor independence will decrease expansion card costs because PC makers can reduce development costs by not having to redesign every product cycle. As a result, they can extend each board's capabilities cost-effectively without completely retooling their systems to accommodate new processor technologies and architectures. ■

Chan is principal of Chan and Associates, a marketing consulting service for audio, broadcast and post-production, Fullerton, CA.

THOMSON BROADCAST would like to thank the National Academy of Television Arts and Sciences for once again recognizing the experience and savoir-faire of the mother of digital with an Emmy Award. In 1993, THOMSON BROADCAST's continual efforts to promote serial digital

STATE OF THE DIGITAL ART

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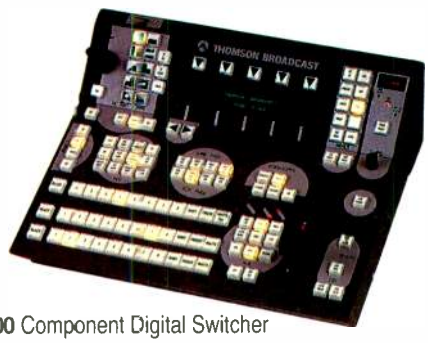

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1993

Technology Update

A nostalgic look back, with an eye to 1994.

As we look forward with anticipation to 1994, feelings of nostalgia also are present from our work in 1993. During this final chapter of '93, it is worthwhile to look back on some of the industry's successes. Three feature articles in this month's issue provide that window into the year's events.

However, there is another event that needs to be recognized this month. For broadcasters, the most significant event in this industry occurred 40 years ago, on Dec. 17, 1953.

On that date, the NTSC color system was approved by the FCC. That event marked the entertainment industry's most important advance since color film.

While the two giants of the day, RCA and CBS, battled for the adoption of their respective color systems, the American public knew little and cared even less about the events. As witness to that fact, despite the addition of color, it took nearly a decade for the boom in color television to develop. New technology, even great new technology isn't always quickly accepted.

The first TV sets were expensive. The original RCA CT-100 15-inch set cost $1,000, and that was in 1953 dollars! Today, sets with a much larger image size, full remote control and stereo audio cost one-third that amount. Compared to 1953 dollars, today's sets cost perhaps one-tenth what they did when color was first introduced.

We've come a long way since 1953 and the first color broadcasts. Now, with interactive capabilities, HDTV and hundreds of new entertainment choices becoming available, more exciting events await us.

So, as we close the year 1993, let's look back at the accomplishments made and progress taken. After all, with the rapid and significant events of this year, you can only wonder at what the next 40 years will hold for us.

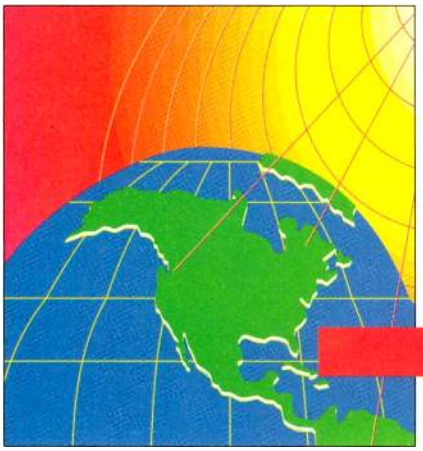
Brad Dick

Brad Dick, editor

- "Perspective of 1993" ..... page 26
- "Interactive TV is on Track" 32
- "Selecting PBX Systems for Radio and TV" 40
- "FCC's Tom Stanley on Broadcasting's Future" ... 46

Acknowledgement: Thanks to Wesley Ott, a technical writer, for his help with this material.

Perspective of 1993



Regulatory and corporate changes highlighted events this year.

By Beth Jacques

The Bottom Line

Now that 1993 is coming to a close, it's time to look back and recount the many technological and regulatory developments that have occurred along the way. These changes are altering the face of the broadcasting, telecommunications and computer industries. From mega-mergers to DAB, HDTV, the information highway and everything in between, these developments will present some interesting curves in the months ahead, before we can anticipate a clear and shining light at the end of the tunnel.

What's a broadcaster to do? The industry was hit high by a Trojan horse from the computer industry when then Apple CEO John Sculley keynoted the 1993 NAB, and hit low by NAB vice president John Abel when he addressed October's SBE fest in Miami. Many chief engineers and station management executives can be forgiven for wondering if this is the year to bone up on codecs — or, for real job security, regulatory law — and fight for a job at Bellcore.

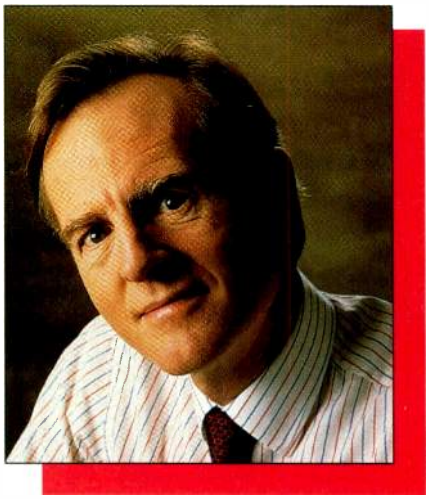
Transition time

First, Sculley tried to advise broadcasters to convince the FCC to give up on HDTV and divide the 6MHz of broadcast spectrum into digital channels. In a bit of crystal ball gazing, he foretold the media demonstration that was to illustrate the autumn's blockbuster Bell Atlantic/TCI merger announcement, describing "intelligent data screens" that will provide viewers with a variety of interactive media choices.

Then, NAB's Abel told radio and TV broadcasters they're the folks on the "hot seat" of the transition to digital broadcasting, charged with the role of "translator, interpreter and facilitator of a new era of broadcasting."

Abel — echoing Sculley, as well as Vice President Al Gore and the Clinton administration's admiration for the new communications paradigm, the digital superhighway — advised the industry to bite the bullet and focus on computer technology. Issues of telecommunications, business communication and convergence also topped his list. Convergence was this year's buzzword, referring to the merger of the media, publishing, telecommunications and computer industries into a single, interrelated industry.

If datacasting (i.e., full digital television) is just around the corner, broadcasters are already getting cozy with the technology. From serial digital studio layouts through new digital switchers, a plethora of new digital videotape formats (DCT, Digital Betacam, D-5, D-6 and, it's rumored, digital ¼-inch), digital video storage devices and next-generation robotic cam-



John Sculley, former chairman and CEO of Apple Computer. (Courtesy of Apple Computer.)

Jacques is a freelance technical writer and journalist based in Brooklyn, NY.

Advanced wireless intercom system

Vega Q600

- **Rugged, reliable, metal beltpack remotes**
- **Hybrid UHF/VHF operation to conserve scarce VHF frequencies**
- **Inexpensive VHF monitor receivers to lower system costs**
- **High-quality, low-noise, low-distortion audio**
- **Up to six beltpacks per master station**
- **Designed specifically for broadcast and production**
- **Directly compatible with all standard wired intercoms**
- **Many advanced circuit and system design features**

In the studio or on the set, Vega's wireless intercom systems are the choice of professionals who demand ruggedness, reliability, broadcast-quality audio, and a full set of professional features. Designed from the ground up for broadcast and production work, the Q600 UHF/VHF system provides all the functions and technical capabilities required for these demanding applications.

The Q600 system provides continuous, full-duplex, hands-off communications between up to six people plus an unlimited number of "listen-only" users.

The QTR-600 beltpack remotes are extremely easy to use and provide operation similar to that of hard-wired intercom beltpacks. They are compatible with popular dynamic or electret headsets, such as Beyer, Clear-Com, and Telex. The cases are welded aircraft aluminum alloy with a high-impact, molded Cycolac (ABS) control panel that will withstand the roughest use.

One QX-600 master station supports up to six QTR-600 remotes with "hands-free" two-way communications, and an unlimited number of PL-2 receivers for listen-only users. Circuitry is provided to interface external line audio with the system or to link two QX-600s into a 12-user system. The master station is directly compatible with all standard wired intercom systems such as Clear-Com, RTS, ROH, Telex, and many others via internal programming switches. A local headset position and extensive control, adjustment, and monitoring provisions are also included.

The PL-2 VHF mini-receiver provides a high-performance, low-cost solution to providing one-way "listen-only" communications. Very often, individuals need to receive instructions but are not required to speak. Using PL-2 receivers for this application avoids the expense of additional full two-way remotes and can significantly lower the cost of a typical system. The PL-2 is fully compatible with the Q600 system and is designed to provide reliable communications in the most demanding RF environments.

When the job demands hands-free, full-duplex operations in the most demanding environment, go with the Vega Q600, the system recommended by professionals worldwide.

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eras are all coming on-line in leading-edge TV facilities.

The radio station's future also is looking binary, through adaptation to new ways of working via digital tape formats DAT, DCC and MD, and especially computer-based automation/production. What's in store for yesterday's hot tickets, such as HDTV, is unclear, however, HDTV may be superseded by full digital broadcasting and/or DBS and the heady scent of full-motion video interactive multimedia (i.e., video games, CD-I and telepresence) promised by the amalgamations of telephony and fiber-optic cable technology.

First, look to Washington. The military/scientific/industrial complex is turning its attention to data and how to best move it around. This group is supported on one hand by a government that is comfortable with and favorably disposed to new technology. On the other hand, it is supported by an entertainment industry that contributes programming to fit every medium from the stone tablet through virtual reality. Programming gurus say that the key to the development of a new home medium is the creation of real-time animation at least 10 times better than that provided by current PC technology and full-motion digital video.

Time line '93

Significant industry events that occurred during the past year.

January:
- Time-Warner announces Full-Service Network (FSN); first residential service in Orlando, FL, in early 1994
- (December '92 carry-over) Formal FCC rulemaking on ghost-canceling; expansion of closed-captioning; FCC enforcement vs. VI reference signal ghost-cancellation suspended, Fall 1992
- FCC chairman Al Sikes resigns; James Quello appointed interim chairman

February:
- Southwestern Bell/Hauser Communications (M&A*)
- U.S. West plans VDT service in early 1994

March:
- FCC retransmission/consent rules finalized; must-carry regulations to take effect in May
- FCC proposes AM/FM guidelines (codification via voluntary IEEE/ANSI standards)
- LMDS (local multipoint distribution service); industry comments to FCC support proposed 28GHz band service, with revisions; satellite industry says mobile satellite service would be harmed
- Former FCC chairman Al Sikes joins Hearst New Media & Technology Group
- Proposed spectrum auction legislation moves through Congress

April:
- FTC reopens 1966 Trade Regulation Rule on deceptive advertising as to size of viewable pictures (picture tube rule)
- U.S. District Court (Washington, DC) rejects cable industry request for stay of earlier decision upholding constitutionality of must-carry (1992 Cable Act)
- FCC proposes rulemaking establishing Motorola C-QUAM AM stereo industry standard; Leonard Kahn objects
- Satellite-based open interactive multimedia platform announced; Participants include United Media, Kaleida Labs (IBM and Apple Computer); Pioneer New Media, Scientific Atlanta, Zenith Cable Products

May:
- NAB vice president of regulatory affairs Howard Wooley joins Bell Atlantic; Time-Warner/U.S. West (M&A)

June:
- MCI Communications/British Telecom (M&A)

July:
- FCC ruling enables telcos to provide video services; AT&T Paradyne and Compression Labs announce ADSL, compressed digital video for video-over copper
- QVC/HSN (M&A); on hold, pending Paramount (M&A)
- 1993 closed-caption decoder circuitry (TV Decoder Act), ghost-canceling rulemaking go into effect

August:
- AT&T/McCaw Cellular (M&A)
- FCC reduces fines (FCC 93-382) for miscellaneous compliance violations; sets new fines for alien ownership, malicious interference; revises late payment fees

September:
- News Media announces 3-country digital satellite data system; expands Satellite TV news; Sky News/BSkyB/Star TV; News Datacom/Comtel acquires Delphi Internet gateway (M&A)
- FCC sets regulatory framework and franchises for broadband 160MHz PCS; launches rulemaking on spectrum auctions; broadcast exempt; DBS and wireless cable probably not
- Paramount: Viacom + Blockbuster Entertainment friendly bid; QVC hostile bid (M&A)

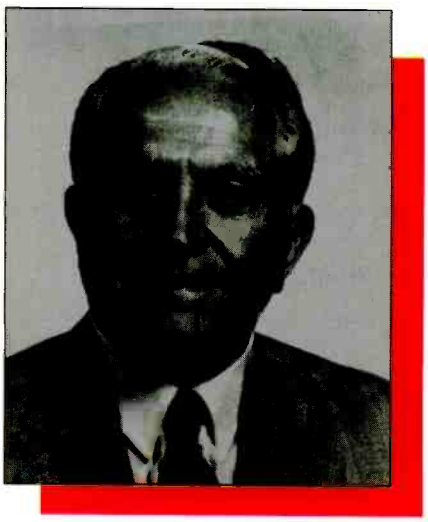
October:
- NYNEX/Viacom (M&A: join bid for Paramount)
- Grand Alliance announces HDTV system technology standards
- Congress confirms FCC commissioner-designate Reed Hundt as chairman
- Bell Atlantic and Tele-Communications propose largest merger in media history (M&A)
- Bell Atlantic/Grupo Iusacell (Mexico) (M&A)
- Bell South/Prime Management (Las Vegas Cable) (M&A)
- FCC announces EBS overhaul for broadcast, satellite, wireless, cable
- FCC endorses NCTA/EIA decoder interface compromise (channel mapping)

November:
- ITU Conference (WRC-93) in Geneva; FCC/NTIA propose simplification of radio and space regulations

** Merger or alliance (telco/cable/other)*

Mergers and more mergers

Convergence, in an industry sense, also can be defined as the merger of many delivery and programming systems into each other. Facilitated by digital technology, the concept of the digital superhighway is a way of referring to digital broadcasting or datacasting as a wideband transmission and information exchange.

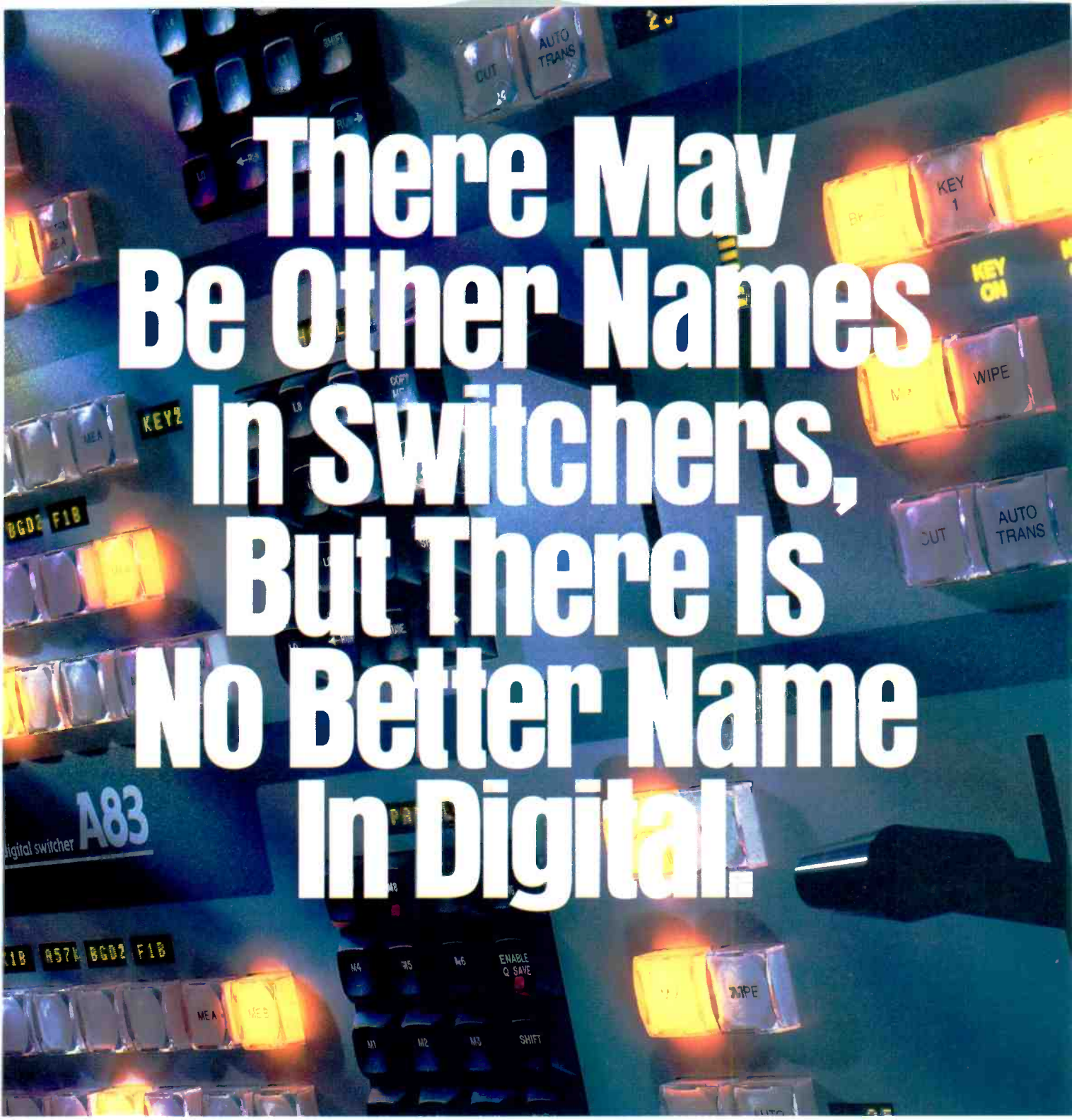


Interim FCC chairman James Quello. (Courtesy of the FCC.)

The theory has already come into practice via last fall's corporate alignments of telco RBOCs, cable system MSOs and program providers following the August federal court ruling (U.S. District Court, Alexandria, VA) that overturned the law prohibiting telephone companies from providing TV programming over their networks.

Although the decision will be appealed, the way is clear for multibillion dollar competition to broadcasters from phone and cable interests, which are now positioning themselves to provide services that include hundreds of TV channels, on-line shopping and 2-way communications services (including video dial tone (VDT) and video on demand (VOD) over fiber-optic networks.

Although the most spectacular, and potentially litigious, deal was the Bell



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Atlantic/TCI merger in September, it's only the most visible. Currently playing out is the $2.5 million May deal between US West and Time/Warner, which is undertaking interactive TV testing in Orlando, FL; the Southwestern Bell acquisition of two Washington, DC-area cable systems; and, either in a move of corporate misdirection or just bad timing, the NYNEX $1.2 billion attempt to buy into Viacom (tied up, at press time, with the Paramount/TCI/Liberty Media/HSN/Bell Atlantic struggle). The FCC went on record to say it saw no federal regulatory roadblock to the NYNEX investment unless Viacom had cable facilities in the NYNEX region.

Still, the only hands-down winners will be the lawyers. Calling it a regulatory nightmare, industry experts predict the Bell Atlantic/TCI alliance won't come to market until around 1995. Among the upcoming regulatory hurdles include seeking a Justice Department waiver from the 1984 Bell System divestiture rule (which barred any Bell company from the long-distance business); clearance from state agencies overseeing cable television (and state utilities commissions); permission from approximately 1,600 municipal franchising authorities to approve the transfer of TCI; congressional and FTC approval that the merger won't stifle competition; and an FCC petition to transfer TCI's microwave-radio licenses to Bell Atlantic. It's therefore no surprise that the FCC is hiring 250 new lawyers just to handle cable reregulation.

The same pattern of convergence is beginning to appear in related areas, such as the News America/News Datacom expansion into international satellite data transmission (initially, via Sky News' interest in BSkyB [BritishSky Broadcasting] and on-line computer services [the Boston-based Delphi Internet gateway]) as well as broadcast, cable and print. Coming into focus are the checkbook negotiations between various DAB and DBS radio proponents.

Ironically, there are already a few mixed signals along the digital highway. Vice President Gore's September National Performance Review noted that "failure to adapt to the Information Age threatens many areas of government." He recommended consolidating all non-military U.S. international broadcasting entities into USIA (Radio and TV Marti, Radio Free Europe, Radio Liberty and the upcoming effort directed at China). However, the Clinton administration in general, and TCI's John Malone in particular, support the concept of an interactive/multimedia/decoder box on every television.

Regulations

The FCC asked for cake and the opportunity to eat it, too. In its October recommendations to Congress were concerns regarding the recent NCTA-EIA call for compromise on cable/consumer electronics compatibility. These compromises included short-term aids, such as the prohibition of scrambling on the basic tier, having unscrambled signals delivered directly to the television, requiring cable systems to provide set-top boxes with multiple descramblers, and the accom-modation of the viewer's own remote. The FCC's longer-term goal is the elimination of scrambled signals and set-top boxes. The FCC would require that all systems built or rebuilt after a specified date use the IS-16 channel plan, first developed in 1983 and since amended, which specifies numbering and frequencies for 153 channels. Under this plan, IS-16 will be expanded as needed.

Digital HDTV Grand Alliance picks technologies

The Digital HDTV Grand Alliance has named four core technologies to be incorporated in the upcoming digital HDTV system proposed to the FCC:

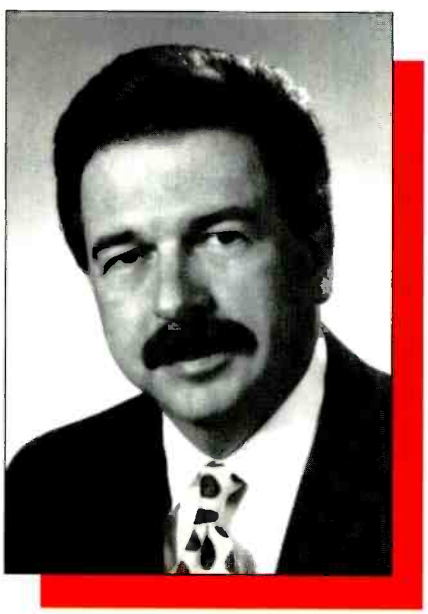
1. Video compression: MPEG-2 (Moving Pictures Experts Group) and B-Frame (bidirectional frame motion compensation.)

2. Transport: Packetized data transport system for most combinations of video, audio and data; compatible with MPEG-2 transport layer.

3. Scanning formats: 24-, 30- and 60-frame-per-second progressive scan, with 1,280 x 720 pixel format. 24- and 30-frame progressive scan, with 1,920 x 1,080 pixel format. 60-frame-per-second interlaced scan, with 1,920 x 1,080 pixel format.

4. Audio technology: 5.1-channel Dolby AC-3. ISO/MPEG2 audio (Musicam) will be tested further for use as a back-up.

Broadcast and cable transmission technology will be named in early 1994. (Systems to be tested include VSB and QAM broadcast modulation systems plus higher-data-rate cable modes.)



John Abel, vice president of NAB. (Courtesy of NAB.)

HDTV vs. NTSC

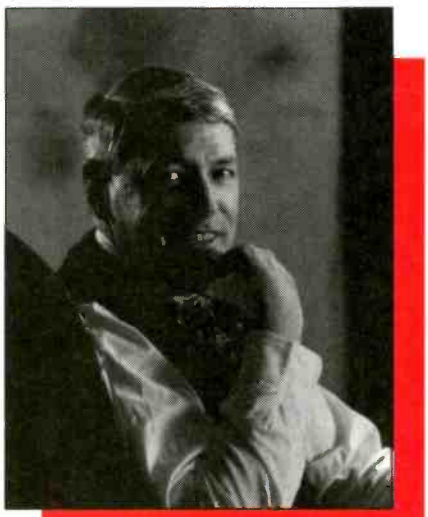
Amidst predictions that the HDTV format will be outgunned by digitally compressed NTSC TV because audiences would opt for quantity of programming choices over video quality, broadcasters responded to the third FCC HDTV rulemaking on the issue last winter. They said they needed maximum flexibility to use HDTV channels for new services. As currently envisioned, those include ancillary data, multiple video channels, interactive and 3-D television. The five proposed HDTV systems being tested can all carry at least 100kbps of ancillary data, with the possibility of allocating more.

While other multimedia interests lobbied hard against a premature adoption of either MPEG or MPEG2 compression technologies, the HDTV developers' alliance — formed earlier this year — backed MPEG. Both were said to be struggling toward key performance capabilities, including symmetrical real-time encoding, scalability and frame-accurate random access in forward and reverse. Irwin Dorros, the FCC's Advanced TV Advisory Committee chairman, said HDTV should be compatible with MPEG, unless a deviation could be justified to the committee.

The MPEG2 video standard agreement, which was reached this summer in Sydney, Australia by the Moving Picture Experts Group, is expected to act as a de

facto standard to guide computer chip manufacturers to develop and produce market-ready MPEG2 chips by the middle of 1994. Said to build on MPEG1, MPEG2 supports interlaced video formats, increased image quality and other advanced features, including those supporting HDTV. The MPEG2 standard extends to 2-15Mbit/s data rates and also is designed to support a range of picture aspect ratios, including 4:3 and 16:9. Early adopters are expected to be satellite systems with frequencies available for new services. Both compression systems support interoperability with the CCITT H.261 video telephony standard,and MPEG2 devices can decode MPEG1.

Significant issues that continue throughout the testing process focus more on the cost of making HDTV equipment suitable for U.S. production and consumer use — particularly in compatibility requirements for interlaced and/or progressive scan — than the quality of data. The one sure thing is that multiformat HDTV receivers will be more expensive. According to manufacturers, progressive scan systems will be seven times the cost of interlaced, and advanced multiformat configurations could cost 20% more than that. At the very least, the current Grand



John Malone, president and CEO of TeleCommunications, Inc. (Courtesy of TCI.)

Alliance plans call for a universal format decoder to be included in every receiver, so even a "basic" interlaced HDTV set's cost will be increased by a small amount.

At press time, the HDTV timetable called for technical subgroup review of compression system specifications submitted earlier this fall, a call for transmission system specifications at the end of November, and a draft lab test plan due before Christmas. Setup at the ATV Test Center will begin in January. Testing will be carried out June 20 through Aug. 29, 1994, and lab reports are due by the end of October 1994.

More must-carry

In other important news this year, the commission's must-carry and retransmission consent rules became final in March, with compliance rolling out over the spring. As predicted, a bitter summer of discontent between cable operators and broadcasters, salved only toward fall with liberal applications of cash and/or network establishment of cable channels.

Must-carry applies to wired cable systems, which can designate their principal headend, while wireless cable and SMATVs are subject to only retransmission consent. Cable systems must carry all program-related material in the VBI and sidebands of the video signals they retransmit, such as closed-captioning, but they don't have to carry non-program information, such as non-video data systems embedded in TV signals. Consent also must be obtained to

carry broadcast radio and LPTV signals.

Other features of the must-carry rule include the definition of all program services delivering at least 15 hours of programming a week to more than 25 stations as "networks." Also, pure VDT systems are subject to the rules unless programmers use them for common carriage. Furthermore, the FCC refused to limit the amount of retransmission consent fees a broadcaster could charge.

In September the FCC set new horizontal ownership rules for cable, despite a decision upheld by U.S. District Judge Thomas Jackson that invalidates parts of the Cable Act. The NCTA went on the record that constitutional issues involved could be expected to end up before the Supreme Court. By the end of the third quarter, few retransmission consent deals had been finalized and the FCC was busy signing 60-day extensions.

Ghost-canceling

Also under way in 1993 was implementation of FCC rulemakings on ghost-canceling, which is probably the most serious NTSC artifact remaining to be dealt with. Meanwhile, new options for closed-captioning were also considered, following the 1990 TV Decoder Act, which included the Americans with Disabilities Act, which became law in 1992, and the July 1993 Decoder Circuitry Act.

Agreeing with the NAB, the FCC chose ghost-canceling over the vertical interval reference (VIR) signal as the best way to use line 19 of the VBI. The FCC stopped enforcement actions against broadcasters who were already doing so. The commission also supported the EIA's request to double the data space available in closed-captioning through use of field 2 in line 21 of the VBI, as well as field 1.

PCS and EBS

In September, the FCC set a regulatory framework for Personal Communications Systems (PCS) and began rulemaking on spectrum auctions. Although most mass media services are excluded from competitive bidding for the spectrum, both wireless cable and DBS licenses are subject to competitive auction, pending comment. The commission plans to develop strict criteria for broadband PCS auctions to make sure that new services, as opposed to warehousing for future use, result. PCS has been allocated 160MHz, four times that originally allocated to cellular.

Among other rulemakings and proposals are the FCC's decisions to test a new EBS system, to rule on RF emissions, and to revamp the system of assessing fines and penalties.

To date, EBS has only alerted viewers and listeners on broadcast channels. The FCC is considering elimination of the current system and moving to automated EBS for a wider range of services including DBS, wireless systems and cable.

Responding to a congressional request, the FCC has declared C-QUAM the U.S. AM-stereo standard.

New RF radiation standards proposed last spring, in line with more restrictive ANSI guidelines, suggest that manufacturers of cellular phones might have to prove handsets aren't harmful. At the same time, approximately 750 FM and 500 AM radio stations may have to bring transmitters into compliance. The new guidelines separate users from people brought into casual contact with RF radiation and microwave energy.

Of fines and formats

In terms of penalties, major fines will be imposed for alien ownership violations and malicious interference. Fines will be eased for exceeding power limits, failing to respond to FCC communications, and failing to comply with prescribed lighting and marking. New fines include those for failing to have a licensed operator on duty, violation of the broadcasting hoax rule, and AM tower fencing infractions.

Congressional legislation in August mandated increased station user fees on top of licensing fees. Commercial stations will have to pay between $4,000 and $18,000 in user fees, which will be allocated to operational costs at the FCC.

In audio news, the 100 Year War between Motorola and Leonard Kahn, developers of competing AM stereo systems, appears to be drawing to a close. Responding to a congressional request, the FCC at last declared C-QUAM the U.S. AM-stereo standard. Kahn still is not giving up, however, and is said to be planning some response. Other issues and developments involve DAB, most notably multipath propagation tests, part of the EIA/NRSC Digital Radio standardization process.

Also worth watching were the contending formats and proponents of both terrestrial and satellite digital radio broadcasting systems nipping each other's heels throughout the year. Current con-

Continued on page 72

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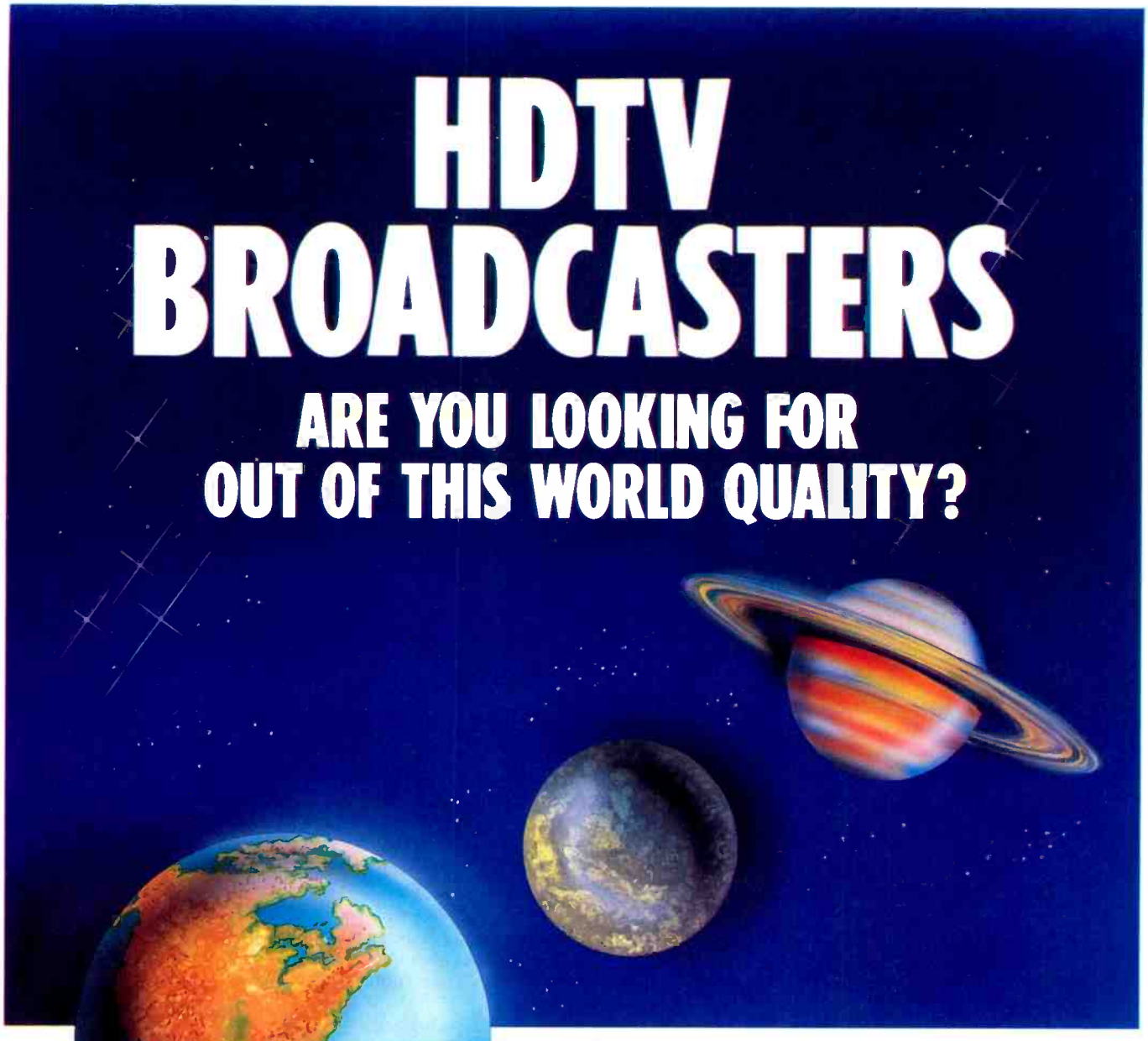

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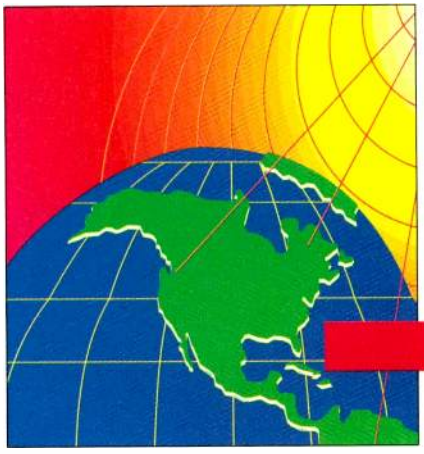
Interactive TV is on track



Is your facility ready to take advantage of the opportunities interactivity can offer?

By Beth Jacques

The Bottom Line

Now that interactive television has been around for awhile, forward thinking stations have had some time to consider the unique opportunities and profits that it can provide. It is up to individual stations to decide how they want to get involved in this emerging technology. Is your station on the right track?

$

When "gee whiz" interactive cable systems, such as Time-Warner's QUBE in Ohio, were first built in the early '80s, almost nobody noticed. The interactive industry is now back at the plate, spurred by new designs, a new generation of viewers weaned on bank teller machines and computerized video games, and FCC flexibility on the use of Interactive Video and Data Service (IVDS) radio spectrum (Docket 91-2, Jan. 16, 1992).

Now that interactive television is back in action — buoyed by the communication industry's revelation that reasons to kick back with a beer in front of the tube need some spicing up and soon — the lucrative mass-market media buys could be a thing of the past. They're funded by deep pockets indeed, including the American public; via stock offerings from companies including Interactive Network, Inc., Mountain View, CA; Video Jukebox Network ("The Box"); and Reston, VA's EON (formerly TV Answer).

Network broadcasting companies (particularly NBC) and cable-system MSOs, which industry experts say already own the majority of coax currently running by American homes, are busy laying fiber-optic cable at the rate of 85 feet per hour. Couch potatoes of the '90s who look to nothing more than a quiet hour scoping the soaps will find that passive viewing is just one comparatively tiny entertainment opportunity to be provided by the interactive TV set of the future.

According to Frost & Sullivan, an international market research firm in New York, revenues from interactive television are about to explode. This was a point first made in a report it issued in August 1992.

Frost & Sullivan points out that "a huge confluence of industries sees interactive TV as a key to its future growth."

The interactive industry is now back at the plate, spurred by new designs.

"From IBM and GM (through its Hughes Communication subsidiary) down to start-ups, such as TV Answer (EON), and tiny program syndication companies, virtually every major company involved in the fields of consumer electronics, TV production, broadcasting, cable , professional video equipment, telecommunications and computers is pouring money into development," the report states.

Worth approximately $681 million in 1991, the emerging interactive industry will balloon to $1.65 billion by 1995, the company predicts.

This will come about because Americans are doers. Soon viewers could be asking for more information from a news program, will sound off en masse in a Larry King electronic town hall, will remotely control programming of a VCR in

Jacques is a freelance technical writer and journalist based in Brooklyn, NY.

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absentia or direct-response purchase a zirconium hot tub with simultaneous bank account direct debit, and more.

The options seem to be unlimited. Already viewers can interact with televised sports, games shows and prime time news/talk programs or educational shows with Interactive Network. (Interactive Network "wired" the 1992 Olympics for play-along sports fans, and will repeat the process for the 1994 Winter and 1996 Summer Olympics.)Viewers can play along with game shows like "Wheel of Fortune," respond to advertisements, predict the plot twists during "Murder, She Wrote" and work with interactive program guides (via, for instance, Portland, OR's Interactive Systems, Inc.; KBLCOM's Star Response push-button addressable/fiber-optic-wired system in San Antonio, TX; and Prevue Network's Trakker Interactive System, first tested on Cox Cable in Tulsa, OK, in 1992).

Today's new services are more flexible and dynamic.

The simple direct-response interactive services of yesterday offered push-button cable box commands for pay-per-view entertainment, phone-call orders for Ginsu knives and national real-time opinion surveys via televised 900-telephone numbers. Today's new services are more flexible and dynamic. Although the earlier "cause-effect" (catch the ad, call the number, and get your product) media interactions and pay-per-view entertainment orders are still considered interactive transactions, the exponential increase in capability supports a cornucopia of new methods of transmission, delivery and display. These systems are enabled by new developments in digital technology, the rapid U.S. penetration of fiber-optic cable, and the convergence of a wide variety of media interests, from program-makers through box manufacturers along with service industries and regulatory interest.

Interactive: What it is

First, the concept of scalable signals and customer registration will considerably broaden the definition of what the consumer knows as television. Cable operators and telephone companies, for instance, will be able to use network software and digital compression to scale their signals to offer enhanced video features, such as pay-per-view and, in some cases, up to 500 channels of viewing fare.

Full interactive television is built on the premise that television is a one-way infor-

mation and entertainment vehicle, which can be turned into a 2-way communications tool. Modeled on large-scale, wide-area-network computing, the development of actual or simulated full-function, 2-way video was enabled by the 1992 FCC establishment of IVDS.

In essence, IVDS is a point-to-multipoint radio concept providing 2-way interaction with commercial, educational and informational programs and data services, delivered by either broadcast television, cable television, wireless cable or DBS. Although heavy consumer demand for anything more than an Elvis compilation or a blacked-out world heavyweight bout has yet to be confirmed, subscribers to GTE's *Main Street* test site, running on Daniels Cable in Cerritos, CA, can already play card games with each other, bank by phone, listen to music, order movies and study for SATs.

For cable and broadcast applications, one Canadian operation (Videotron, a multiplexed system) and three U.S. companies (Interactive Systems, Interactive Network, and EON Corporation) are in various stages of rollout. Among other things, each features interactive games or Q&A-style multiple choice templates superimposed over real-time sports and game show broadcasts. Terrestrial delivery systems include the PBS VBI, the VHF spectrum, telephone networks and the encoded light. Encoded light is a technology called *LiveLite* and is incorporated as part of Interactive Systems *Veil* (Video Encoded Invisible Light). Information is encoded on film or live TV program material and is transmitted as an invisible light beam together with the broadcast signal to a viewer's set-top box, and then to a remote-control device for home operation.

Delivery of the interactive data via VBI (lines 11-20) is an alternative form of transmission currently available to approximately 60% of homes in the United States.

Interactive Network, which is available in the San Francisco Bay Area and Sacramento Valley as well as in Chicago, recently signed a programming deal with Sony/Columbia. Interactive Systems' proprietary encoded-light (Veil) technology, is available to 4,000 households in Spain (as TelePick). This service will be offered in The Netherlands and Australia soon. EON is in contract negotiations with 18 tentative licensees in nine top ADI markets following FCC licensing agreements in September. (With implications for a potentially broadened market, William Laumeister and Robert Broughton, co-inventors of the *LiveLite* encoded light system , initiated suit against the Oregon company in Santa Clara, CA, last summer for fraud and failure to pay royalties. Under the terms of the contract, default leaves Laumeister free to market *LiveLite* to others.)

Technology

Based on a combination of broadcast, cable, wireless cable, DBS delivery and IVDS point-to-multipoint radio service, implementation of interactive television of any stripe currently requires add-on consumer hardware and downloaded software.

A set-top box or a modem is required, whether for an interactive game box, such

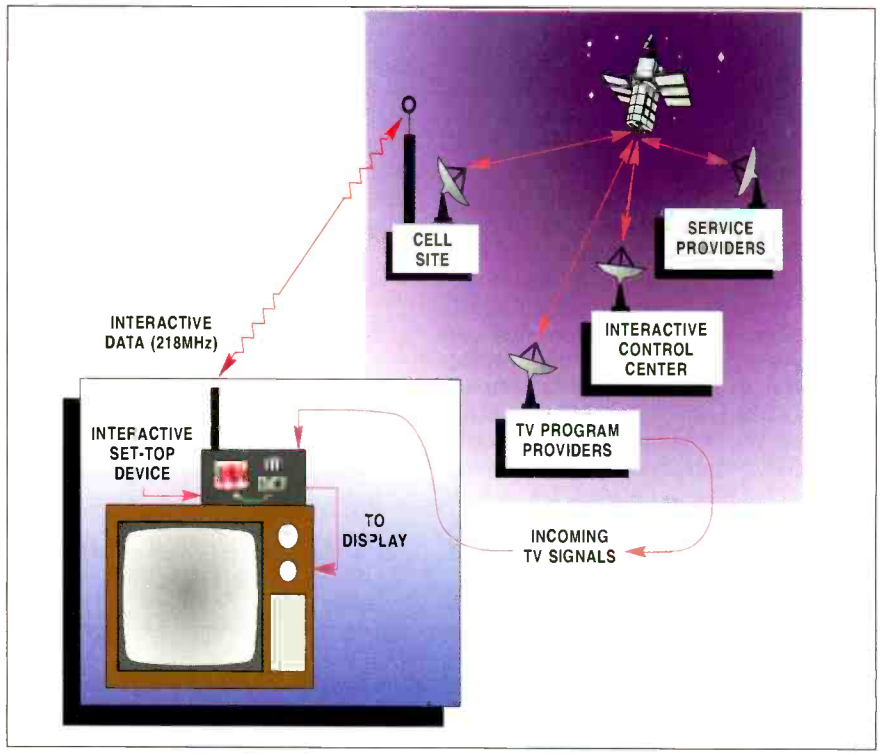

Figure 1. *One type of interactive system uses a set-top device to transmit data from the viewer to a cell site where it is uplinked to a satellite. The information is relayed to the control center for processing. Providers can then fill requests and if necessary send return information to the customer's TV screen.*

as 3DO's; a CD-I player to store such information as memory-intensive graphics and other information triggered by linear and/or dynamic information arriving over cable; or a typically fault-tolerant, real-time distributed control unit. Also required is a remote operating device and access to a home telephone line or cellular/RF service.

In one system, (Interactive Network's) reaching the mass market is achieved by linking a network of FM stations via digital telephone lines (56kbit/s). Data modulated on SCA FM subcarriers is broadcast to subscribers synchronously with TV programming. Data is transmitted via a packet data network upload in the system's central computer system, and the return path from the home is achieved via a 10-second local phone call via the consumer control unit's onboard modem.

Delivery of the interactive data via vertical blanking interval (VBI) (lines 11-20) is an alternative form of transmission. As with delivery of closed-captioning material, it's achieved by inserting data on the VBI.

Both live-insertion and pre-recorded/time-coded applications (via VITC, LTC or internal PC clock) of interactive data transmission "prompts" can currently be achieved by some systems. When running an interactive event in sync with TV programming live, a producer station is connected to a system's central computer, and to the actual event via an ID number specified in scheduling. At that point, a producer can send messages to consumer control units tuned in to the broadcast.

For time-coded events, a binary image of the script is created and loaded into the central computer system together with an input file name matching the one selected by scheduling. When the program begins, sync is monitored with off-air signals of program audio and video. Timing adjustments (typically in 0.2-second increments) can be made via interface to the central computer system's supervisory and control functions.

Also promising to be an important player for the delivery of interactive services is digital cable.

Programming is typically enabled by an application shell downloaded to a consumer's control unit for a given event; it is made interactive through a mix of information screens, survey questions and Q&A screens. Basic production system features include a script tool for each production element the Q&A screens support, a time-code manipulation tool, cut-and-paste editing, file merge (so a number of writers can create scripts),

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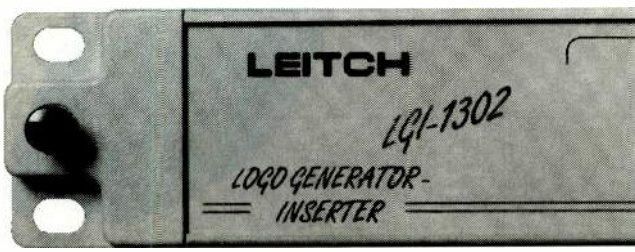

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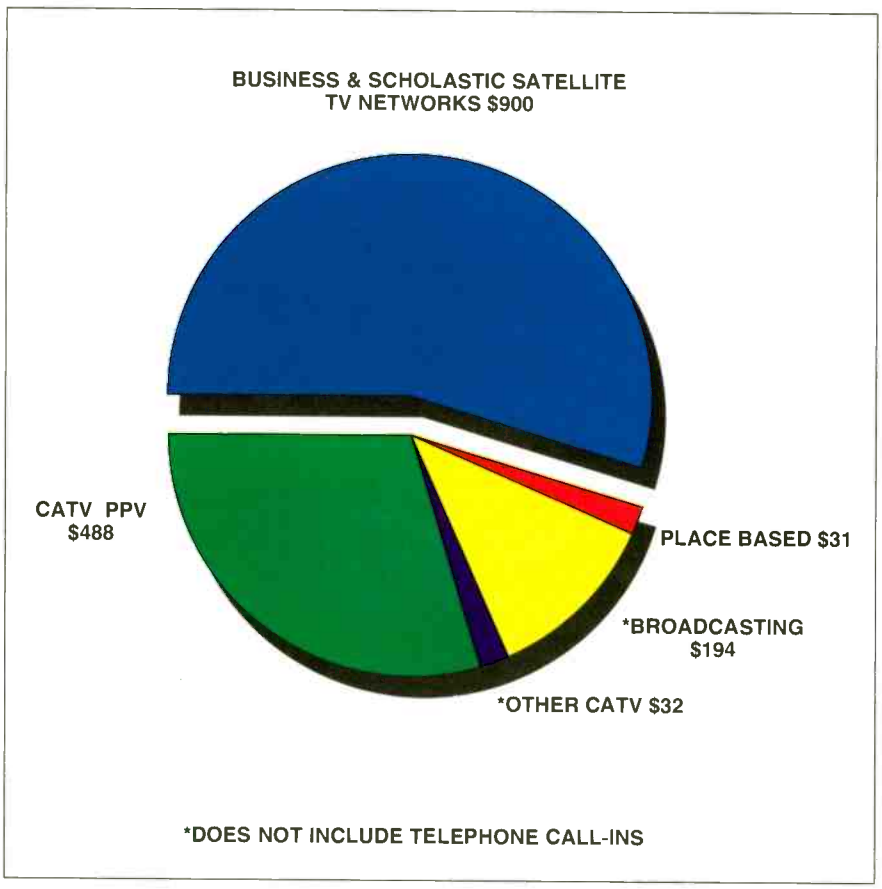


Figure 2. *1996 projection for interactive revenues by market segment. (Courtesy of Frost & Sullivan, Inc.)*

and a live production interface.

A second interactive system (EON's) requiring similar consumer interface equipment has been constructed around RF-based digital technology.

EON's home set-top unit is a combination CPU and radio transmitter/receiver, operating on the RF spectrum of 218-219MHz. Linked to the Hughes VSAT Network System, the local cell site is a 1.8m send/receive satellite dish, with a 6m whip antenna to communicate to consumer units. (See Figure 1.)

Other delivery methods that claim interactive capability include advances in computer technology, such as Modular Windows, which can enable such developing services MTV+ and ESPN+; a high-resolution cellular system service in the New York area (CellularVision), which deploys the previously unused 28GHz "millimeter spectrum" to deliver narrowcast programming and interactive services to window-mounted consumer

Other delivery methods that claim interactive capability include advances in computer technology.

microwave receivers; and Video Dial Tone (VDT). Recently given the legislative OK, VDT allows Regional Bell Operating Companies (RBOCs) to deliver television and video services over their telephone infrastructure.

Also promising to be an important player for the delivery of interactive services is digital cable. For instance, promised to its subscribers by 1995 by cable giant TeleCommunications, Inc. (TCI the largest MSO in the United States, even before its announced merger with Bell Atlantic), digital cable joins the toolkit of this media colossus that already owns a compressed-video joint venture with AT&T and General Instruments; a satellite uplink deal; ownership in content companies (such as TBS, BET, Disney); and several interactive PPV and home shopping services.

What's in it for broadcasters? The wherewithal to stay in business, primarily. Because broadcasters, cable TV companies and phone companies all view interactive television as a means to expand into each other's territory, they also see such cross-territorial competition, currently actively encouraged by government, as their biggest hope for increasing revenues. (The government sees such competition as benefiting consumers through decreased rates.)

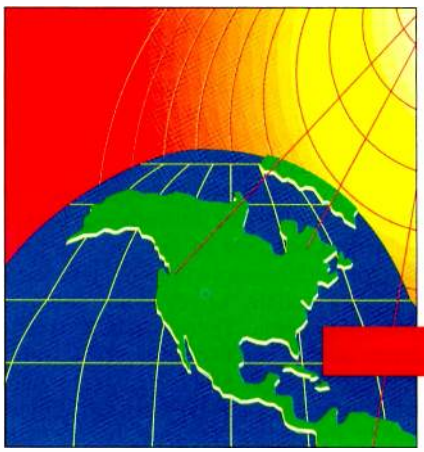
Because broadcasters, cable TV and phone companies view interactive TV as a means to expand into each other's territories, they see cross-territorial competition as their biggest hope for increasing revenues.

Interactivity is important for broadcasters, especially those who face the fragmentation of the market for mass media (and hence declining ad rates) and a seachange in the underlying structure of the U.S. economy, which will put less purchasing power in the hands of consumers. If there is an upside for broadcasters, industry pundits say, it's the comparatively inexpensive cost of entry: a stripped interactive encoding system for a broadcast station need only include a personal computer, a VBI encoder/decoder and a VSAT uplink. For an outlay of approximately $20,000 to capture national 800-screens and image advertisers, broadcasters can spice up their programming, project a "state-of-the-art" image to local viewers and advertisers, and improve their ratings.

But industry analysts are still asking the same pesky question. Tom Adams, who recently left Kagan Associates, a Carmel, CA, research firm, to join Advanstar, a direct-response and video industry publisher, asked, "Why turn your TV into a computer when you'd really rather watch TV? Or go fishing?"

Industry statistics also make Adams wonder whether the ability to — gee whiz — bank at home or access 500 channels of information will tempt consumers to purchase initially pricey home interactive equipment. "There's a lack of evidence people want to interact" he said. Plus, most people still concentrate their viewing on the same five channels. Could one of those five favorites become an interactive channel? This is today's 64 billion dollar question. ■

Selecting PBX systems for radio and TV



Choosing the right telephone system is critical to the proper operation of a broadcast facility.

By Steve Church

The Bottom Line

Since telco deregulation, broadcasters have provided for their unique telephone needs with specialized telephone hardware — customer-provided equipment (CPE), in telco parlance. At first, this equipment required modification or in-house fabrication by broadcasters, but much more has become available off-the-shelf. Today, broadcasters' expanding phone-system requirements and emerging telco services have created the need for a new generation of telephone equipment, and manufacturers are responding. Choosing among these new offerings is a crucial and challenging process.

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Telephones are intrinsically boring. Unlike that new graphics tool or audio effects device, telephones just have to properly perform a single, simple task: Putting the call through.

However, choosing a new telephone system is getting more complicated each day. Technology from the computer and data communication field is having a major effect on telephone equipment and services. Although broadcasters share general telephony requirements with other kinds of users, they often ask their systems to handle the unusual when it comes to the "back of the house" — call-in lines, multifacility interconnection, remote backhaul/communications and telemetry. As a result, the selection of a centralized, computerized in-house telephone switching system (the approach preferred by most broadcasters today) is a critical one. These systems are generically referred to as *private branch exchanges* (PBXs).

The thousands of PBX systems and permutations present many options to the

Church is president of Telos Systems, Cleveland, OH.

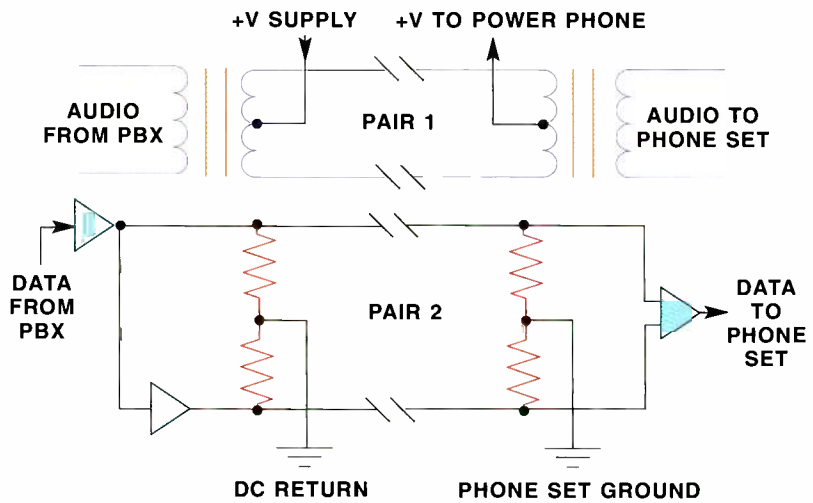

Figure 1. *Different phone systems communicate in different ways. This common analog PBX approach puts audio and control data on separate pairs, with power applied in "phantom" form across them. (Signal flow shown in one direction only for simplicity.) Other analog systems use a separate pair for power or multiplex the control data onto the audio pair. Digital PBX systems typically use a single pair for audio, data and power.*

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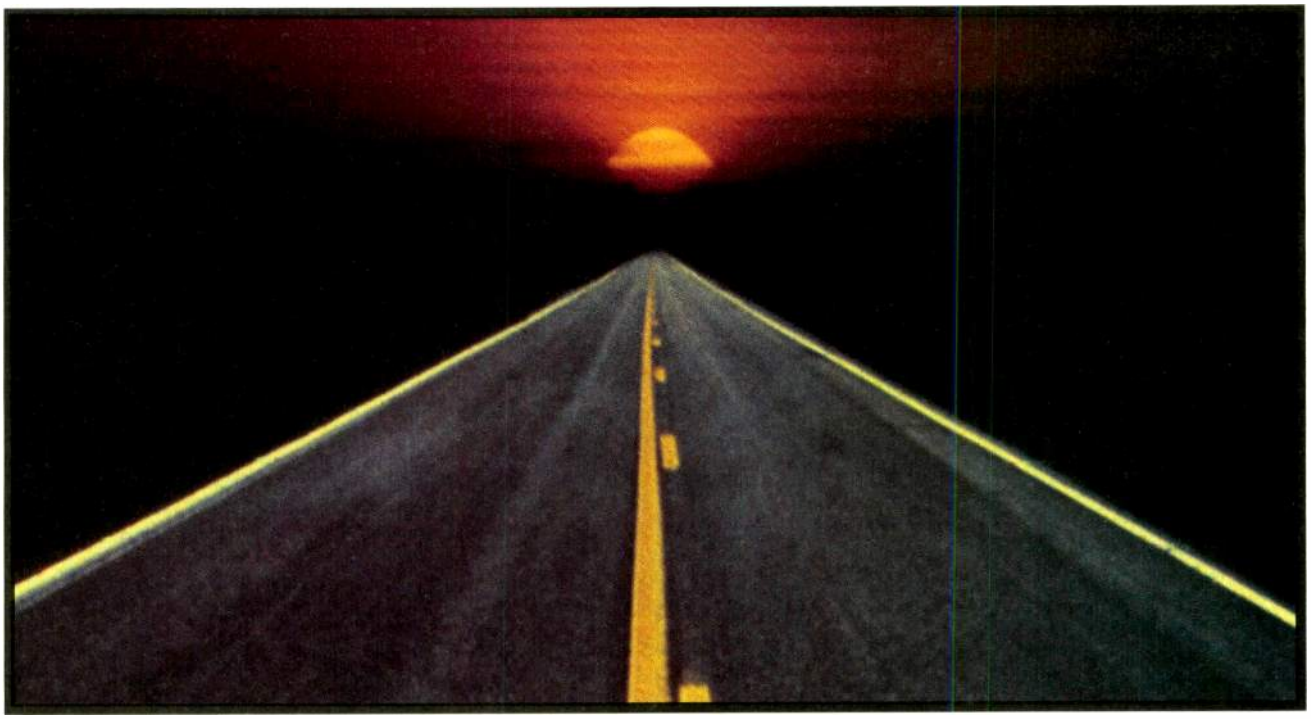

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prospective purchaser. To begin narrowing the field, a good place to start is with the relatively simple issue of *capacity*.

System size

Fortunately, broadcast facilities' requirements for lines and phones are fairly stable over time. When preparing to invest in a large central phone system, however, it is important to think far ahead. Will it be necessary to add ports for auto-answer couplers? Should each department's fax machine run through the system to take advantage of least-cost-routing? What about any special requirements from programming, such as once-a-year telethons or audience information lines? Are there users with dedicated modem lines that could be more inexpensively served by pooled service? Will future business partnerships create a need for off-premises extensions or tie lines? The list goes on, and every facility's list is different.

For most PBX systems, there are three sizing decisions. The first is the initial number of lines and phones in the system. Second is the number of lines and phones the system can handle by plugging in more phones, adding more circuit cards and making minor wiring changes. The final consideration is the system's *maximum* size. How many lines and phones are possible by adding expansion modules or cabinets?

Large PBXs are modular and consist of racks with modules in shelves. The configuration is determined by selecting the appropriate module type and quantity. The shelves may usually be expanded in the event that more capacity is eventually required. The modules also may be rearranged at will. This provides plenty of flexibility to handle whatever might come up in the future. PBX capacity is measured in *ports*, which can be used either for connections to telephone sets or to the telco central office (CO).

Smaller systems are generally more limited. Some are fixed at a given size, and those that are not have only limited expandability. A system that is sized 16/48 will take 16 lines and 48 phones — period. In this situation, you have to be more certain about your future needs because you are more locked-in.

System design

What's more important is the underlying transmission technology. Today, large systems are nearly exclusively designed to switch in the digital domain. Nevertheless, connection to the outside world can be configured as either analog or digital. On the telephone set side, ports may be assigned for connection to basic 2500-style phones (standard telco instruments) or to proprietary multibutton feature sets. Modern proprietary sets al-

How to buy a PBX

Here's a step-by-step process of bringing a PBX system on-line at your facility.

Step 1. Get equipment literature and narrow the field. Contact local vendors and ask for literature on systems in the size range that you're considering. You may want to make clear that sales calls are only to come upon request, and at a later time. Carefully go through the literature. Eliminate any systems that seem inappropriate.

Step 2. Make decisions about wiring. If new wiring is required, this may be the time to extend computer interconnection to everyone's desk. The same cable that connects the phone to the common equipment also can serve as a high-speed data link for the station's computer LAN. The latest technology for computer data-sharing is *10BaseT*, a variation of ethernet. The hub goes in the phone closet, and the same kind of punch-blocks used for the phones serve the LAN.

The wiring process is labor-intensive, with only a small portion of the cost in the cable. It makes sense to put in a fairly big multiconductor with plenty of extra capacity. There is such a thing as *data-grade* cable, which should be installed when LAN use is contemplated.

Step 3. Get proposals. Tell the salespeople what you think you want, and then listen for what they can provide. This is a good time to ask pointed questions.

Get them to bring you a phone set. Does it seem to be well-constructed? Are the buttons well-positioned? Will the display be legible in a dim studio?

Tour your facility with the vendor. Point out the location of all phones and related equipment. Point out any special conditions or requirements. Determine the state of the existing phone wiring.

Get formal proposals on paper. Be sure that any special features or conditions, such as provision for on-air interface, are clearly spelled out.

Step 4. Visit vendors and their customers. These visits are time-consuming but potentially rewarding in the quality of intelligence gathered.

Even if you've already visited with salespeople in your own conference room, it's a good idea to return the visit. Have prospective suppliers show you how many spare parts they stock, how they respond to service requests, what their service vehicles look like, and what their *own* phone system is. If it is like the one you are considering, make some calls on it. Evaluate the audio quality and operational features. Perhaps you can make some measurements.

Arrange visits to other clients of these vendors who use systems similar to the ones they have proposed for your facility.

Step 5. Pick the winner and negotiate the contract. This is the time for horse-trading. See what you can get to sweeten the deal: spare parts, additional features, maybe an extended warranty.

Step 6. Plan the installation. Work with the vendor to ensure that all details are covered. Set a date. Consider a few final points:

- Phone systems should have dedicated power circuits. They are, after all, computers. They also operate continuously. If you do not have a dedicated circuit for the PBX, consider having one installed.
- Consider surge arrestors, voltage stabilizers or uninterruptible power sources (UPS) as part of the new system. Prices for UPS continue to fall, with many models aimed at the high-volume personal computer industry. Large PBXs have the option of operating from storage batteries, just like at the telco CO.
- Is the present common-equipment location OK? Phone maintenance people don't like working in cramped conditions. If the system is hidden in a dark, dismal basement, your phone service will probably be terrible.
- Is ventilation adequate? As with all equipment, the system won't be at its most reliable in a hot, dirty room.

Step 7. Cutover. Decide the cutover method. There are two kinds: *flash cuts* and *parallel cuts*. Flash cuts are done instantly over a weekend. With parallel cuts, the two systems work side-by-side for a time, thereby improving the odds that the new system won't cause a phone disaster.

In either case, insist that a technician be on your premises for the first day the system is in operation, and ask that he or she have a few phones and other vital parts on hand. The system trainer also should be on hand.

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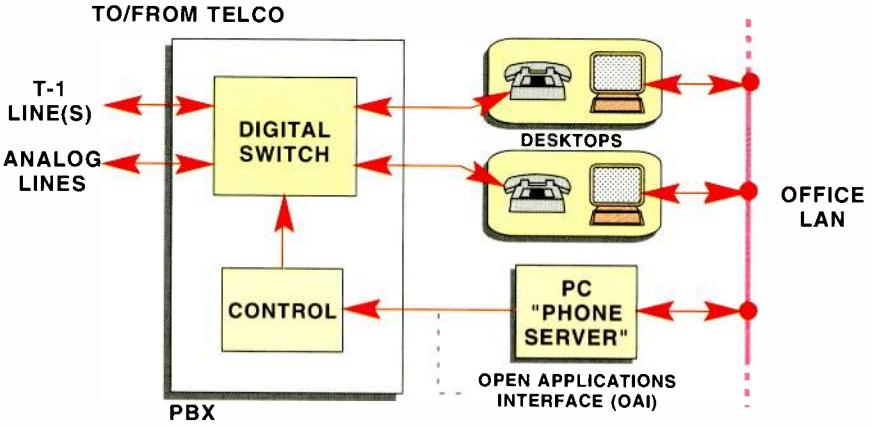

Figure 2. *A possible plan for the office of the future. Using a combination of telephone and computer resources, both systems are integrated for the user at the desktop. The PC becomes a more flexible way to operate phone services.*

most always communicate with the common equipment via a digital bitstream. The control functions and the audio are multiplexed onto this stream, with the analog-to-digital audio conversion accomplished within each phone set.

Although these "feature phones" are preferred because of their convenience, it is usually not possible to easily tap into the audio destined for them because the communication scheme is not intended to interface to outside equipment. Therefore, you will probably need some analog *tip-ring* outputs for connection to broadcast equipment, such as studio on-air systems or auto-couplers for intercom systems. On the CO side of the PBX, analog tip-ring ports are the most common format, but digital formats, such as T-1 and ISDN, are more widely used.

There is more variation with smaller systems. Some use digital technology while others rely on tried-and-true analog methods. The latter use multiple wire pairs to send information to and from the phone sets, with one pair carrying audio in analog form and the other typically carrying control. (See Figure 1.)

Most of today's larger systems offer a way to connect digitally to the telephone network. The most popular technology for this purpose is T-1. This scheme uses two twisted pairs (one for transmit and one for receive) to convey 24 digital speech channels of 56 or 64kbit/s each. *Primary-rate ISDN* is almost the same thing, but with a more elaborate signaling protocol. These same PBX systems allow those digital techniques to be used on the phone-set side. Therefore, it is possible to have completely transparent digital paths through the switching system.

Features

Voice mail has become one of the most popular forms of business communication. This capability should be considered in any new system. Although it is possible to have a stand-alone voice-mail system connected to the PBX via analog or digital ports, full integration is considered the best option. Even if management doesn't want it now, it's a good idea to size the system so there are some spare shelf openings to add options of this kind later.

Selected cities in 34 states now have *caller ID.* In a few other states, it is offered almost everywhere. A system that supports processing and display of ID data may be appropriate for some broadcast-specific applications, such as talk show call-in lines.

Conferencing is a basic feature, but it merits some discussion. Most PBX systems include this function, but often there is no audio gain inserted in the caller-to-caller path(s). This means that conferenced callers are at the mercy of the incoming phone lines' quality/level when it comes to hearing each other. High-quality conferencing requires special attention and equipment.

Some PBX features can significantly reduce a broadcaster's operating expenses. The most critical of these is *least-cost-routing.* Offered on larger systems, this lets the PBX choose which lines and/or access codes to use for each call, based upon programmed parameters. For example, as a large user, you may have a direct connection to a long-distance *point-of-presence* (POP) in order to save the cost of the local phone company's long-distance routing fees (paid by you indirectly through the per-minute charge from the long-distance provider). In this case, the PBX can be called upon to make the routing decisions to send calls outside of the local area to the long-distance path, while allowing local calls to proceed to the standard local phone company lines.

Station message detail recording (SMDR) capability also may help keep costs down. This is a system that records all call activity for later scrutiny. Simple systems merely print each call as it happens onto fanfold paper in the phone closet. It's not likely that the typical overworked accounting department will be able to effectively make use of this data deluge. However, if problems are suspected, a scan could turn up some helpful information. A step up from this is a system that uses account codes, so that calls are tracked to a given user or project regardless of the phone set used to make the call. The downside of this approach is that users are required to punch in the codes with each call — a process that can become tedious. The ultimate method enables the PBX to download the call information to floppy disk rather than paper. The disk data can then be analyzed using a PC or a service bureau can be employed.

Related to SMDR is *toll-restriction.* Long-distance calling can be limited to numbers in designated exchange areas on a per extension basis in most systems.

Speed calling is a popular feature saving employee time and money. Almost all systems have this function, so the only issue to consider is ease of use. Some systems make programming and access of numbers difficult.

Computer interfaces and open systems

Microsoft and Intel have announced *Windows Telephony,* which includes a *telephone applications interface* (TAPI) standard for computer application developers and telephone hardware manufacturers. (See Figure 2.) This package of software and standards will eventually lead to Windows-based software applications, from simple personal phone listings/autodialers to fancy LAN database packages. The goal is to allow computer systems to talk to phone systems in order to perform call setup, retrieve caller ID, establish conferencing — everything that is now done from feature phone sets, but with the more flexible user interface that can be provided by computer screens and keyboards.

It is expected that this interface will be included in the next major release of Windows sometime in 1994. This offers an unprecedented opportunity for third-party developers to add special functionality to formerly closed phone systems. It also may allow them to become "voice servers" in an integrated LAN system.

At the close of 1993, it's difficult to know what this means for most of us, but it would probably be a good idea to make sure that there is some commitment from any vendor you are considering in which an open interface will be supported. Perhaps one measure that will help you decide if the vendor will be supporting the Windows interface is to look at the cur-

Continued on page 52

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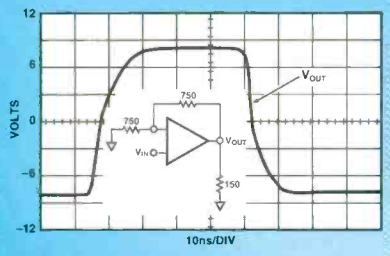

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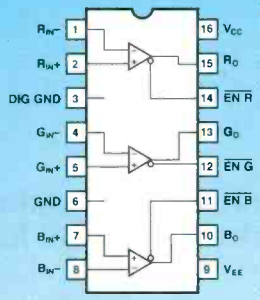

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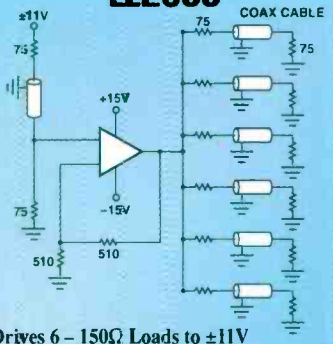

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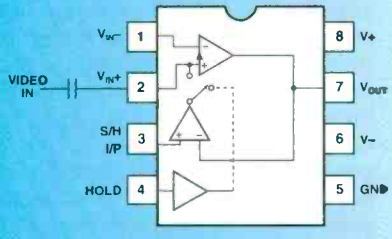

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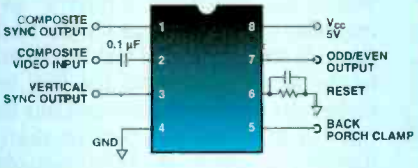

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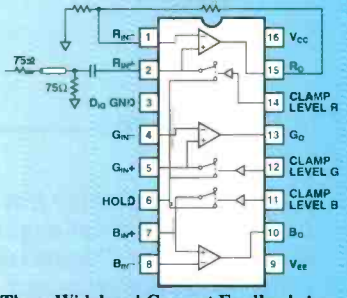

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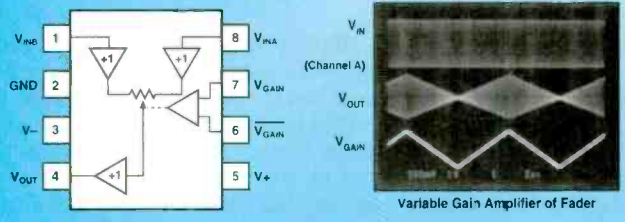

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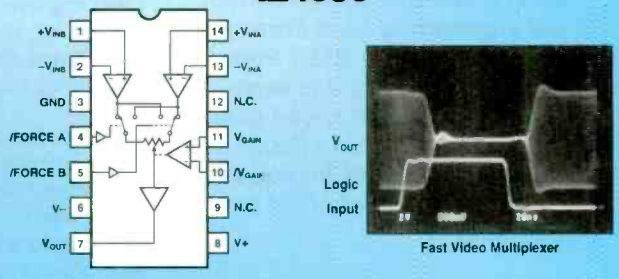

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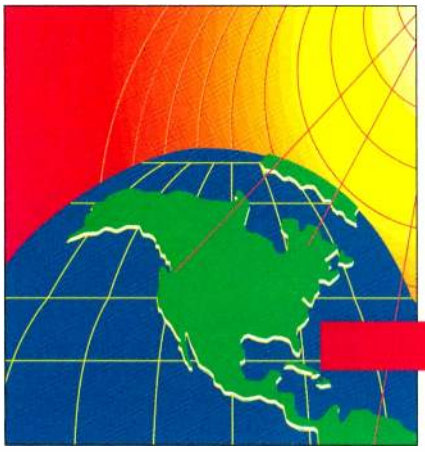
FCC's Tom Stanley on broadcasting's future



America's top regulatory technologist looks at what lies ahead for broadcasters.

The Bottom Line

Dr. Thomas Stanley has been the FCC's chief engineer and chief of the Commission's Office of Engineering and Technology (OET) since 1986. He joined the FCC in 1981 after holding positions at the Institute for Defense Analysis, the U.S. Army Signal Corps and Bell Labs. He holds a Ph.D and a master's in electrical engineering from Princeton University, and a BSEE from Johns Hopkins. In this exclusive interview, he spoke with technical editor Skip Pizzi about emerging technologies and their potential effect on the industry.

The myriad changes that technology is bringing to telecommunications has created a sense of urgency and uncertainty within the broadcast industry. As the regulatory body charged with keeping the industry in line and viable for service to the American public, the FCC keeps close tabs on these issues and has developed a different perspective than the industry at large might have on all of this. It is a surprisingly upbeat and positive view, although it acknowledges that much work and many unsettled issues remain.

Broadcast Engineering's editors felt that readers might benefit from sharing this unique and important notion of what's coming and how it is likely to affect broadcasters and their audiences. No one is better qualified than the commission's chief engineer to present this outlook to broadcast technologists. He does so frankly and eloquently in this wide-ranging, timely conversation.

BE: *Dr. Stanley, what do you see as the most pressing and immediate areas for growth and change in broadcasting?*

TS: Almost everything we're looking at is changing a lot and going through what are called *system changes* or *major upgrades*. In the broadcast world, the next generations of television and radio loom fairly large on our horizon as activities that I think will require some regulatory decisions — I'll just say in the next year at a minimum.

BE: *What is your sense of the way matters are proceeding with the HDTV alliance?*

TS: It looks to me like the Grand Alliance has already made more progress than any of us would have expected. They've come to the commission three or four times now, and have briefed the staff on their progress and what problems remain. They seem to show a great deal of cohesion and a strong sense of a single purpose — they even finish each other's sentences. They seem well-directed. A year ago at this time, they were all separately trying to look good and perhaps take some pot shots at each other. I think they've shown a great deal of progress. On technical matters, they are taking this charter now — not from the commission, but from the industry — to come up with the best digital standard they can, for the sake of future broadcasts. They seem strongly oriented toward doing their best on that problem.

BE: *Do you feel that they're going to come up with a system that will satisfy the broadcast and the computer-display industries?*

TS: I have a fairly strong sense of optimism there. I think that when most people in other arenas of life talk convergence, you could certainly point to this particular group and say, "They're really doing the convergence." If you go back just about four years ago, there was no conversion calendar and the world was still very much analog. Digital was not just around the corner, but off the map in terms of not fitting the kind of decision cycle we thought would be required.

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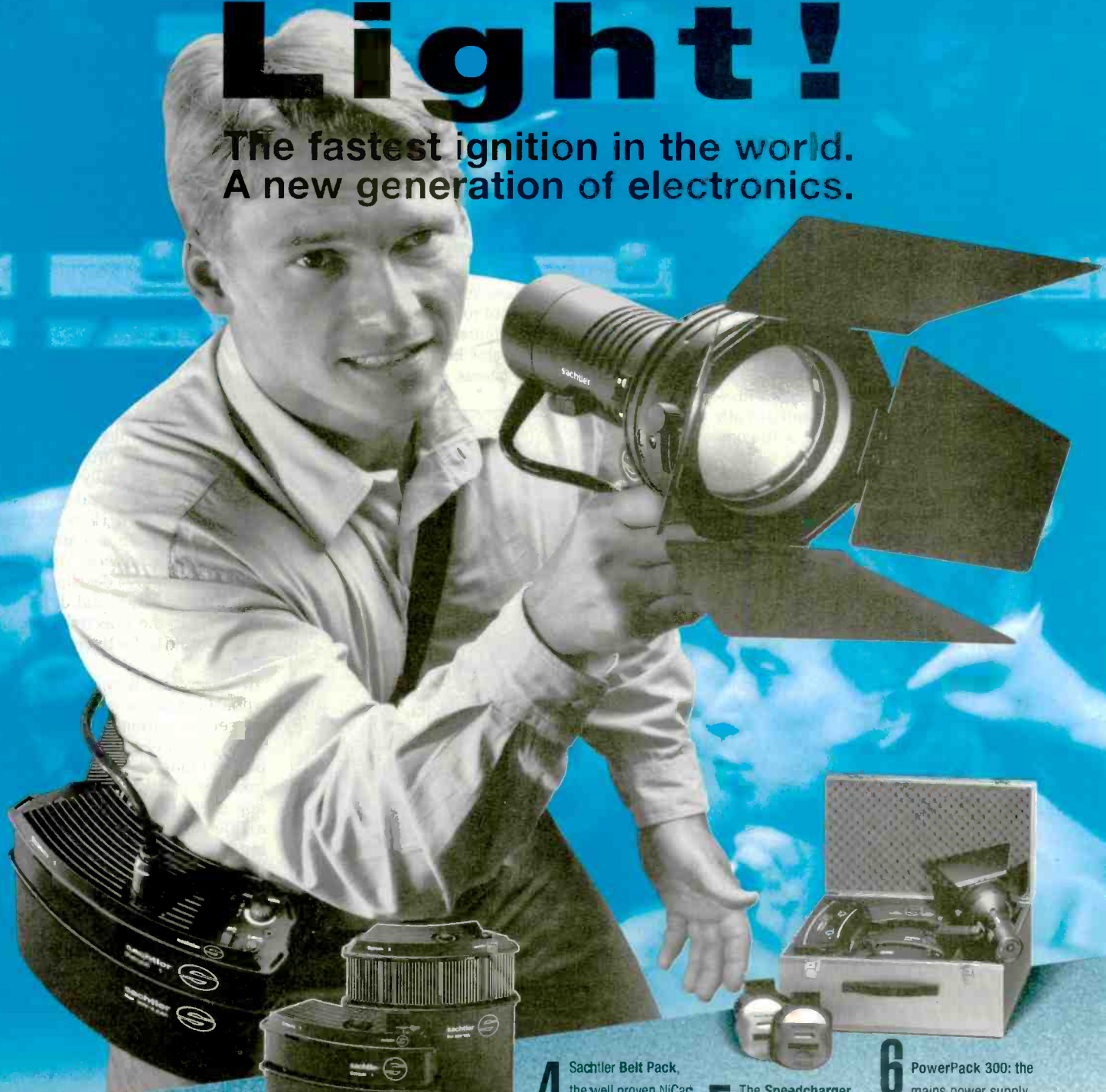

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and it has great features that make it extremely computer-friendly. For example, it includes square pixels, which was an issue subject to a great deal of criticism previously. It is packetized with a great deal of potential for addresses and headers that other systems can use for different purposes.

Another tough issue involves progressive vs. interlaced scanning. What has a lot of agreement is doing *both* for some period of time, with different paths from the current interlaced world to progressive. Except for what I would call a minority of strong holdouts for all progressive/no interlace — which I think is just too extreme for the regulatory world — it looks like there's a centrist path that will probably bring both communities together.

BE: *In the midst of all this, it seems likely that we'll see the dawn of DBS TV broadcasting early in 1994. What's your sense of the situation there?*

TS: I'd say more video from the sky as opposed to through fiber. I think it just increases the likelihood of the role that people had said they had seen for DBS in the early 1980s — a variety of video sources competing with broadcast and cable. I think it's a slightly belated fulfillment of those kinds of predictions. Economically, and in terms of market choices, its impact may be somewhat subdued, depending on the cost of the service and number of channels and physical hardware requirements. I think its impact would have been greater a decade ago, before such a heavy penetration of the U.S. video market by cable. Figures suggest that more than half the homes — even up to 60% — have cable and that at least 90% are passed. So it may well be that a DBS service is simply coming now into a more crowded marketplace.

BE: *When and where do you see the current issues on cable TV settling?*

TS: Congress has given the commission quite a bit of extra work to do in beginning to re-regulate cable. The OET actually has a major unsung piece of that activity, and this has to do with compatibility between future consumer electronics and evolving cable systems. For example, picture-in-picture and other kinds of multiple channel features really don't function well because of the presence of a converter. So as a minimum, the commission has undertaken an inquiry to ask where these areas are going, and then see at what point the consumer electronics industry and the cable industry can get together at some level to define common interfaces or some approach that settles some of these ruffled feathers, regarding how their respective technologies are evolving.

BE: *In that context, are you also looking ahead at perhaps a 500-channel universe and the complications that it or a video-on-demand system might bring to the table?*

TS: I think the official answer is probably yes. But more practically, most of the kinds of features people are talking about are more immediate. Yet, your point really is that it's hard not to look at the cloud of this immense potential number of channels looming. It seems like that's a challenge to cable systems or any kind of video delivery system in simply providing the ability to *choose* stations, much less interact with them.

Dr. Thomas Stanley, chief engineer, Federal Communications Commission.

Many of the consumer electronics/cable interface problems are multiple-channel problems, so I think numbers on the order of 500 can only frustrate any kind of standards activities. Our attempt is to look for relatively immediate activities to alleviate a fairly immediate consumer problem. The longer-term health of that interface will certainly be hampered by those kinds of numbers. But let's say that's probably a respectable second phase for the process to undertake.

BE: *Moving on to radio, is DAB — or "DARS" (Digital Audio Radio Service), as the commission calls it — another item that's high on the action list?*

TS: Absolutely. Unlike HDTV's current 6-year process, digital audio broadcast only kind of cracked the FCC's rulemaking frontier in mid-1990. So we're roughly three years in, and it has not exactly been three hectic years in terms of progress and development. The process was kicked off by a petition from *Satellite CD Radio*. But it isn't just the benefits from satellite service — it's the potential benefit and impact of an upgrade to the *terrestrial* radio broadcast service. It's much a part of the same decision package.

When the commission initiated the rulemaking, it really asked what the benefits of such a platform are, what its impact would be on the terrestrial broadcasters, and what the options are for terrestrial broadcasters, all with a brief reference to HDTV. For HDTV, it was decided early in the process that the technology looked largely possible but that no new spectrum would be identified. Also, the current providers of TV broadcast would really be the principal offerers of the next generation. In other words, HDTV is not a new service, but rather an improvement of an existing service. We haven't made those sets of decisions yet for digital audio radio, and don't quite know what the spectrum requirements would be for terrestrial digital radio.

It's not clear how a new service would be implemented without turning certain stations dark for a significant period of time. The entire implementation or transition process from the existing service to a new upgraded service is not clear. It was a little clearer for HDTV. I'm not being negative; it's just that many of those early things that seemed clearer — given HDTV's state-of-the-art at that time — are not clear today with the advent of digital audio radio. There is still a lot of looking into the potentialities of digital radio service from both terrestrial transmission and satellites. However, no singular technical standard has emerged from either area.

The only development, I might add, is in the spectrum area, and the developments actually came along with a great degree of difficulty (WARC-92). That was followed last fall by an FCC NPRM, where we essentially implemented the 2,310-2,360MHz S-band allocation from WARC in the United States. That's really where it sits today. This is somewhat difficult for coordination because our neighbors to the North and to the South — Canada and Mexico — have chosen the L-band options, so we really find ourselves sandwiched in between different concepts for the delivery of these kinds of new technologies. It's hard to be optimistic about easy solutions, not only from the spectrum point-of-view, but also from the point-of-view of what standard to pick. I might add that Canadian documents have indicated they want to come down and change the U.S.

mind about some of our spectrum ideas. So I don't think that portends well for smooth or prompt solutions. We've done well in the HDTV area, however. It would be great to repeat that same kind of success for a DAB standard.

An important issue is how to implement it. Television took advantage of the taboo channels. The poor performance of UHF receivers by their nature kept some prohibited channels going, and HDTV is capitalizing on those kinds of holes in the system. Radio isn't quite so fortunate, although there are some distance and adjacent-channel constraints. But there are no empty channels that one can put the signals into easily. Now that's not a great barrier, because one can add to the existing radio channel various additional signals. But this has to be developed, and it raises concerns about interference.

BE: *Could you characterize your preferences from a regulatory standpoint on the so-called in-band DAB systems vs. those that would require new spectrum?*

TS: I can't say that this is a deep look at the problem, but so-called in-band approaches have enormous regulatory benefits. The idea that there is a neat in-band solution is the great hope. I think everyone's instincts about pushing hard for in-band solutions are exactly right. I might add, no matter what happens with the satellite domain, it simply behooves broadcasters to look hard as to what is the best signal or process that they could add to their own existing signal that would give rise to that kind of quality improvement. The potential is there for improvements, and they're going to certainly find whatever that is. Now, as for how to get there, it isn't just a quality trade-off. The problems with the existing radio bands are fairly significant.

BE: *We hear that the commission might consider limiting or at least holding off for a while on DBS radio because of its potentially adverse effect on the existing broadcast industry. Given the system proposals and the NPRM already on the table for S-band DBS radio systems in the United States, what is your sense of how that is going to proceed?*

TS: It's hard to talk about limiting satellite services any further than they're already limited by virtue of being a satellite service. Any satellite service, I've noticed, has a pretty tough row to hoe. Getting spectrum domestically in an environment that I guess would have to be competitive, and then fighting for the international allocation and coordination process — those are surely formidable things. I think any satellite system that passes the hurdles will already have a difficult physical and economic existence.

In the 1980s, we were giving talks about how the decade of the '80s would be the time for mobile satellite service. Well, the '80s have come and gone, and there still is no mobile satellite service to speak of. They're always just around the corner from something happening. I have difficulty seeing the commission at this stage intentionally espousing any idea that would limit a technology that is in this early formative stage, for the sake of a terrestrial broadcast world where the jury is still out on the workability of an in-band standard and how it might fit in. It may well be there's a good in-band standard out there, so the best that terrestrial broadcasters can do is hurry up and get their digital in-band standard developed.

Worrying about satellite services is really worrying about something that's always a few years off. I'd be troubled by anything that ever intends to hold back any technology for fear of harming incumbency. I think the commission has said that the public should be the beneficiaries of this kind of technology, and because it's tough to get it going anyway, I don't think any discussion of limitations is a useful or fruitful path.

"I'd be troubled by anything that ever intends to hold back any technology for fear of harming incumbency."

BE: *In terms of innovative services, let's discuss what's been called "cellular television" — the new 28GHz service. Your terminology for it is LMDS, I believe.*

TS: That's right — Local Multipoint Distribution Service. I think this office should be enthusiastic about any service that seeks to go up to that part of the spectrum. It's really like encouraging — in terms of land development — those areas outside the suburbs to start growing, and I think there's a positive development there. When you go into the hinterlands of the spectrum, more spectrum is available, so maybe you are more generous with the "blocks." The higher you go in spectrum, as in this case, you can better control propagation through power service areas. So there's a great reuse. There are major public interest benefits in using those upper frequencies to do anything, and distribute video is kind of an easy one because of the wide bandwidths available.

BE: *What are your impressions on the issues of "convergence" — for lack of a better term — between telcos, cable and broadcasters?*

TS: I think an awful lot of the discussion is Utopian in terms of these vastly different markets and techniques converging on anything. But it's a natural progression for system and technology development. We engineers always look to the bounds and extremities and design for them. And in the case of telco, cable, broadcast and related activities, many of these constraints — at least the artificial ones — are regimes and distinctions brought about by us regulators and the courts. Hence, you wonder what kind of systems could be designed if you could go beyond them. How would the public be better off?

From a technical perspective, I think this is simply good health that we challenge all those boundaries between types of service and the regulatory regimes. I think that bothers the stability in the regulatory and legal worlds. There's something nice about the broadcasters doing their thing and cable people doing their thing and so on. But I think there comes a time when the idea of convergence is just too good a bet to pass up. The public may well be the strong beneficiary of our taking down some of these barriers. For many of them, their days are numbered and they will cease to be, but I think they're going to have to be undermined by the economics. When the economics undermine the reasons for these regulatory distinctions, then I think they'll fall, and the sooner the better.

BE: *That also implies that entertainment is likely to be the engine driving much of this.*

TS: I think so. I think you'll find that the quality-sensitivity and the vast size of that market are powerful factors in this technology push. High-definition television and higher quality radio are the next obvious developments — I think people will want those. The price tag has to be established and I think it's driven principally by the desire of people simply wanting a good entertainment service. The entertainment industry is a powerful engine of change here.

BE: *In particular, the Bell Atlantic/TCI merger has drawn a lot of people's attention to this issue. How does that development strike you?*

TS: I think it's a large development. In the last 12 months, there must be a half-dozen developments, a digital high-definition standard being one, PCS (personal communication services) being another, plus what's happening in the industry: the TCI/Bell Atlantic or the AT&T/McCaw Cellular deal, and so on. Any one of these is a major development in the course of what communication goods and services are and how they would be offered.

Continued on page 52

On the horizon

Emerging technologies continue to pour forth from the digital audio wellspring.

By Skip Pizzi, technical editor

The Bottom Line

As 1993 comes to a close, more new applications of digital technology are poised to enter both the production and transmission domains of radio. Among these are new methods of audio transport and new applications for auxiliary datacasting. The first may significantly reduce costs at the radio station. The second may increase revenues. The effects of both innovations may be felt imminently.

$

Digital audio transmission for point-to-point signal transport is becoming popular in both wired and wireless forms among radio broadcasters. Typical uses include remote backhaul and studio-to-transmitter link (STL) applications. Available bandwidth has always been the limiting factor to digital audio transmission, and therefore data reduction algorithms are key to these applications.

Another advantage of audio digitization has yet to be fully exploited, however. To date, most digital transmission schemes used in radio (T-1, Switched-56, ISDN and digital 950MHz STL) have involved *real-time* audio feeds. This is only natural, given the analog roots from which this technology has sprung, but it is no longer a necessary constraint.

Non-real-time transmission

If an audio feed is not required to be aired live, but rather received, recorded and replayed on air later (as is often the case in remote backhaul or network distribution), it doesn't need to be transmitted in real time. This implies that it can be fed at a slower-than-real-time rate, and, therefore, narrower bandwidth paths can be used for high-quality audio transmission. Bandwidth is simply traded for time in the ultimately fungible world of bits.

The 1.5 million bits of linear PCM data required by every second of CD-quality stereo audio can be cut to 200,000 or 300,000 bits per second (bps) by data reduction algorithms, but this still requires a fairly wide bandwidth path for real-time transmission.

Yet, if the user can tolerate five or six seconds of transmission time for every second of audio program length, that data-reduced, near-CD quality stereo can be transmitted through a Switched-56 circuit. (In real time, Switched-56 is generally limited to 7.5kHz mono data-reduced audio.)

A basic-rate ISDN circuit could carry this same digital audio data with a 2:1 or 3:1 time ratio. If the user can tolerate a 20:1 time ratio, this near CD-quality stereo can even be received on a regular analog dial-up telephone line.

This technology is now in use for the distribution of radio commercials to stations. A San Francisco company, Digital

The DGS receive/play terminal is now in use at more than 500 stations for non-real-time audio transport.

Generation Systems (DGS), sends spots to stations using Switched-56, ISDN or standard analog dial-up lines — whichever the station (and its local telco) supports. DGS also maintains incoming lines to its network hub from production houses, for receiving spots just after they are produced via the same non-real-time technology. The company claims that their system allows stations nationwide to air spots in as little as four hours after they are produced.

Hardware requirements

Although the concept of trading time for bandwidth seems simple enough, it requires a specialized, asynchronous recording and playback device. Of course, in today's environment, this device (or at least the basis for it) is now commonplace — the desktop computer and its hard disk drive. DGS adapts such a device for its specialized service (see photo on page 50), but other, smaller-scale users have employed a standard PC with appropriate off-the-shelf peripherals for the same function.

After non-real-time reception of the audio data file, the computer outputs the data in real time for dubbing to a conventional audio recording device of the station's choice. (A future variant envisions keeping the data in its computer file status for direct use in a digital automation system.)

Basic hardware includes a fast CPU and a high-capacity hard drive (120Mbyte or larger recommended), an audio converter card (such as those offered by low-end workstation makers for approximately $1,000) and terminal hardware — a high-end modem for standard dial-up telco (14.4kbit/s, V.32-bis, MNP recommended), DSU for Switched-56, terminal adapter for ISDN, or network card for high-speed Internet connection.

Additional PC cards for data reduction are available, but these add significantly to system cost ($1,800 and up). If program lengths are short enough, audio bandwidth requirements are low enough, and interconnection data rates are high enough, you may be able to do without the data-reduction component. For example, a full-range, quiet, mono news spot 60 seconds long (using standard 32kHz-sampled, 16-bit linear PCM) could be fed on a basic-rate ISDN line *without* data reduction in approximately four minutes.

The additional codec costs, therefore, may not be justified unless programming issues so dictate (such as for longer pieces, quick turnaround requirements, coverage of breaking stories and the like). For audio data in this form, however, true data *compression* algorithms (such as *PKZip* or *stuffit*) could be applied to the files before transmission for approximately a 2:1 reduction in transfer time and complete bit-for-bit reconstruction after reception.

Global positioning correction

The Global Positioning System (GPS) is a 3-dimensional, location-finding system administered by the U.S. government, using multiple satellites and dedicated portable receivers. Although the system is inherently capable of high accuracy (limited only by atmospheric propagation and satellite-clocking errors), the data transmitted from the satellites for public use is purposely corrupted to limit standard receivers' positional resolution to a circle of 200m diameter (±100m accuracy in any direction).

The stated reason for this performance degradation (the military euphemistically calls it *selective availability*) is prevention of incoming enemy missiles' acquisition of precise targeting data from the GPS satellites during descent. Although 200m resolution might still seem far more than adequate location data for nuclear warhead detonation, military sources claim that a successful attack on a hardened target actually does require greater accuracy.

In practice, typical ground-based GPS users find that multipath reflections of satellite signals (or obstruction of one or more of the three GPS satellites that should be visible above the receiver's horizon at any point and time) can further degrade the accuracy of the receiver by as much as five times. This means that location accuracy may be reduced to ±500m, and that multipath from urban canyons may create the worst errors in crowded city locations where resolution requirements are greatest.

A solution to this problem is provided by the correction data of *Differential GPS* (DGPS). In this case, a terrestrial signal is broadcast from a transmitter of precisely identified location, and this data is added to the satellite signals in a DGPS receiver. This system can produce positional data down to ±1m accuracy. (This is not a problem for the military because the correction data is only available near the ground, too late for ICBM targeting correction.) Many recently produced GPS receivers are "correction ready," in that they include inputs for add-on DGPS receiver modules. Future GPS receivers will offer internal DGPS integration. (See photo.)

A small GPS receiver with integrated DGPS correction capability.

One new company is offering DGPS service to users via the RBDS carrier of FM radio stations. Differential Corrections, Inc. (DCI) of Cupertino, CA, is currently contracting with FM stations around the United States for use of a small portion (about one-seventh) of its RBDS carriers' *transparent data* capacity — the non-program or non-station-related data groups of RBDS that stations can use for ancillary revenue-producing purposes. (See "Radio in Transition: New Profit Centers," November 1993.)

DGPS and non-real-time audio transmission are two emerging applications that the digital evolution has brought to radio broadcasters. They are likely to have a substantial impact soon.

Editor's note: Special thanks to Terry Denbrook, chief engineer, KUOW-FM, Seattle, for his contributions to this article.

➡ *For more information on companies mentioned, circle the following numbers on Reply Card:*
Digital Generation Systems (312)
Differential Corrections, Inc. (313)

Continued from page 44

rent state of that vendor's Open Applications Interface (OAI). Some manufacturers are enthusiastic supporters of open interconnection; others prefer a more proprietary approach.

Adaptability to the broadcast environment

Some unique telephone system needs at the broadcast facility require special attention. You almost certainly will want to have some tip-ring or plain old telephone service (POTS) ports for analog audio I/O. Therefore, any system should support this possibility.

On the other hand, with the increased use of digital dial-up telco services (Switched-56 and ISDN) for transmission of audio program material, it may be valuable to have the capability to route these circuits through the phone switch entirely in the digital domain. That way, the digital phone lines may be accessible from multiple locations with the advantages of a central switching facility. Next generation on-air (or audio management) systems will likely take advantage of digital connectivity. Therefore, thinking ahead, you will want a system that can provide these digital ports.

If the system retains analog feeds to on-air systems, audio quality will be an issue. Unfortunately, phone manufacturers do not often give audio performance specifications. So you will have to use your own clever resources to make judgments in this area. You may be able to make some measurements on a system set up at the local dealer's office. In digital PBXs, look for analog audio problems with codec signal-to-noise and aliasing distortion. For analog PBXs, the most common impairment is crosstalk from the control signals into the audio along the wire that connects the phone to the switching equipment.

Another unusual requirement at a growing number of facilities is the need for multiple music-on-hold sources. In the past, this has been an issue only at AM/FM combos where the two stations' formats were radically different. As the trend toward LMAs and duopolies continues to engender studio/office consolidations, the need for this capability will increase. Surprisingly, only a few systems offer this feature.

Centrex

An alternative to the purchase of a PBX is the use of a telco's Centrex service. Its main advantage continues to be price. The pitch: You get all of the advantages of a PBX without tying up capital in an owned, on-premises system. The phone company's CO equipment takes care of everything just as an on-site PBX system would, and you only invest in (or lease) the phone instruments. There is no in-house exchange or switching hardware required.

Centrex service has become more sophisticated in recent years. Not too long ago, the only option was to use analog single-line sets with feature access via the primitive method of "switch-hook flash." Now, thanks to ISDN, it is possible to have fancy phones with DTMF or dedicated button access to the usual features. Traditionally, Centrex has been concentrated among large users with thousands of phones — universities and government agencies, for example. Recently, however, phone companies have been aggressively pricing this service to appeal to smaller businesses. The jury is still out on whether Centrex can rival the best PBXs.

Service

Unlike the typical business phone user, broadcasters require phones to be up and running 24 hours a day. Therefore, you will want to know what support your vendor offers after hours. Or you can take advantage of your in-house technical expertise and stock a few spare modules. It's usually possible for the broadcast engineer to diagnose and swap a faulty phone system module. When arranging the purchase of a new system, it makes sense to get some extra modules for emergency replacement purposes. (See "Troubleshooting," September 1992 through February 1993.)

Training should be included in any system purchase. Specify how many hours are included and whether any special training requests (for after-hours staff, for example) can be accommodated.

Programming is generally a job for the pros the first time around. After everything works, however, you'll want to make changes yourself. Therefore, insist that the vendor provide a certain number of hours of good technician support until all bugs are exterminated. Also ensure that all of the manufacturer's documents that describe the programming procedure are left at your site for later use. Perhaps some training in this area should also be negotiated. Note that phone systems vary in their ease of programming. Some are intended for non-technical users; others are best managed by people with weeks of factory education.

Does this all seem a bit daunting? There is a way to ease the pain. In most cities, there are consultants who can advise on system selection and configuration. Of course, you will still have to evaluate the competence of the consultant.

In the end, remember that the station phone system qualifies as critical broadcast equipment. The process of its acquisition is worthy of your best efforts. ■

➡ *For more information on PBX systems, circle (306) on Reply Card.*

Continued from page 49

With this many major developments in just one 12-month period, it's pretty hard to look at and pretend we see exactly what's going on. Specifically regarding cable and telco, I think that's one of those tough regulatory interfaces that eventually is going to change. And it's changing not because the regulators or Congress says it's time to change, but because entrepreneurial forces are pushing back at various aspects along this front.

With this many developments, it's hard to pretend we see exactly what's going on.

Whether this is the first step of something bigger, I really don't know. I have a feeling it is. Any time two large entities choose to merge, it opens a potential for what the new resulting entity can do. As a technologist, an engineer, I find that extremely exciting. The environment of wide bandwidths pervasively available opens up great vistas of new things.

From a regulatory point-of-view, when two monopolies mate, I don't know what the offspring really is. It may be the kind of thing that bears a great deal of watching. So the rules of the road certainly have to be revised, whether it's the Congress' or ours. We have to go through and make sure the various public interest aspects are treated. From the public service perspective, I think it's very, very exciting.

BE: *Certainly no lack of job security for the regulators, it would seem. Finally, have you drawn any impressions of Reed Hundt, the new FCC chairman, or any of the other new commissioners as yet?*

TS: Well, the new commission isn't here yet, but I think we're all looking forward to a new time. My general impressions of Reed Hundt are extremely favorable in terms of an individual sensitive to what the technology could offer and doing that in such a way that makes the regulatory schemes look out for public interest. We don't know what his agenda is, but I've picked up a feeling that he has great sensitivity to what the technologies are going to be bringing to bear here.

I think his term probably falls at the beginning of a period of great change. Change will come to virtually everything we regulate, from technical standards, to expansions of techniques, to new services and new providers. You can't have this many revolutions without an accompanying review of the regulatory process that tries to oversee this. So I think we're due for some changes. I don't think we quite know what they all are. ■

New Products

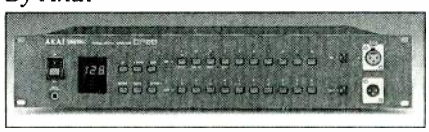
New at AES '93

Shotgun capsule
By AKG Acoustics

• **CK68/ULS:** incorporates a divisible interference tube that allows a single mic to be conformed for different applications; works in conjunction with C460/B preamp; ideal for indoor/outdoor medium-distance recording and front-of-stage reinforcement; removing the front tube turns the CK68/ULS into a short shotgun capsule, which can be used for film to TV close-ups, front-of-stage reinforcement, interviews in noisy environments and other applications requiring reach.

Circle (382) on Reply Card

Patchbay
By Akai



• **DP88:** 2U-space digital audio signal patchbay; provides XLR and two optical inputs and outputs; up to 128 patch configurations may be stored in its internal memory; programs may be selected from the front panel via a foot pedal or by remote MIDI program changes.

Circle (383) on Reply Card

Console upgrade
By Solid State Logic

• **G Plus:** upgrade of the entire G Series console range; offers enhanced sound quality with oxygen-free cable and new op and mix amps.

Circle (384) on Reply Card

Digital surround sound A/V system
By Solid State Logic

• **OmniMix:** new, larger version of Scenaria digital audio/video system; provides dynamic/editable pan automation of up to 38 sources or submixes in 4-, 5- or 6-channel surround plus new audio panning and spatial effects; features a substantial hardware control surface with 16 moving faders, dedicated metering and extensive hard controls; features the VisionTrack random-access video system.

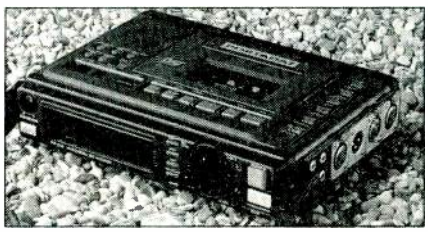
Circle (385) on Reply Card

On-air production console
By Solid State Logic

• **SL 8000 GB:** provides high level of functionality in on-air production; switchable modes of operation for broadcast, record and remix extend console range to make it versatile in any environment.

Circle (386) on Reply Card

Portable DAT reorders
By HHB



• **PORTDAT PDR1000**: uses a rugged 4-head, 4-motor transport; offers 44.1kHz, 48kHz and 32kHz selectable sampling rates, balanced XLR mic/line inputs, AES/EBU/SPDIF digital I/Os and 48V phantom powering.

• **PORTDAT PDR1000TC:** non-time-code portable recorder; in addition to the features of the PDR1000, the PDR1000TC is equipped to jam sync, convert absolute time to time code, and to record, generate and reference to time code in all existing international standards.

Circle (387) on Reply Card

Broadcast console
By Otari

• **B-10:** audio console designed specifically for on-air broadcast applications; available in 14-module and 24-module mainframes; offers mono or stereo inputs with 3-band EQ and four aux sends plus a master output module.

Circle (388) on Reply Card

Broadcast storage/playback system
By Otari

• **Pro-MD:** based on the Sony MD format; offers fast-access, reliable audio storage and playback using the MiniDisc random-access optical disc format, which provides up to 74 minutes of high-quality digital audio recording time per disc; other features include TOC editing; memory start, stop/standby and single/repeat play function modes; a selectable EOM detector, a front-panel headphone output with level control; an audible cue mode and lighted front-panel control with enhanced MD informational readout capabilities, including a min:sec:frm timer, track number indicator, title readout, level meters and a mode indicator.

Circle (389) on Reply Card

Microphone
By Shure Brothers

• **Beta 87:** supercardioid hand-held condenser microphone; features include superior internal shock mounting and a 3-stage pop filter enclosed under its dent-resistant hardened steel grille; also available in a wireless version.

Shure Beta 87

Circle (390) on Reply Card

Pre-amp/splitter
By BEC Technologies

• **MP 16:** 16-channel microphone preamp/splitter; features include 90dB gain control range; 48V phantom power for each channel; non-volatile memory for 99 program settings; LED indicators for signal present, nominal level and clipping threshold.

Circle (391) on Reply Card

All-digital broadcast console
By Sony

• **DMX-B4000:** offers digital signal processing; flexible routing through multiple inputs, an easy-to-use graphical interface, and an integrated, automated control surface; available in 8- and 16-channel stereo configurations; offers 32-bit processing accuracy with 24-bit AES/EBU I/O; can accept up to 30 stereo sources and control multiple devices.

Circle (392) on Reply Card

Tape upgrade
By Sony

• **Pro DAT Plus:** new Pro DAT Plus tape lengths include 15-, 34-, 48-, 64-, 94-, and 124-minute tapes in jewel case package; offerings packaged with an album box include 34-, 64-, and 124-minute tapes.

Circle (393) on Reply Card

Digital audio mixer
By Sony

• **DMX-E2000:** designed for video post-production applications; equipped with serial and parallel remote-control interface connectors; includes 10 stereo inputs, two mix buses and 2-channel preview/monitoring; conforms to the AES/EBU digital format; 16-channel inputs can be connected with up to four Sony Digital Betacam players or other digital audio sources; additional 4-channel auxiliary

New Products

AES (continued)

inputs allow connection with other digital audio equipment; eight AES/EBU output connectors provide four sets of PCM buffered outputs, enabling the DMX-E2000 to supply program outputs to as many as four digital VTRs.

Circle (394) on Reply Card

All-digital mixing console

By Sony

• **DMX-S6000:** large-frame digital mixing console; offers four flexible frame sizes and configurations; offers 32-bit processing accuracy with 24-bit AES/EBU and 20-bit SDIF-2 digital I/O; supports mixing to other digital recording formats, including PCM-7000 DAT 2-channel recorders, D-1, D-2 and Digital Betacam VTRs that can store four channels of 20-bit AES/EBU audio.

Circle (395) on Reply Card

Wireless mic receivers

By Sony

• **WRR-810A and WRR-860A:** offer cost-effective, clear-channel and low-power operation; includes a CPU; WRR-810A uses two AA batteries; WRR-860A uses four AA batteries; WRR-810 supports 94 selectable wireless frequencies, operating in the channels 68 and 69 TV range.

Circle (396) on Reply Card

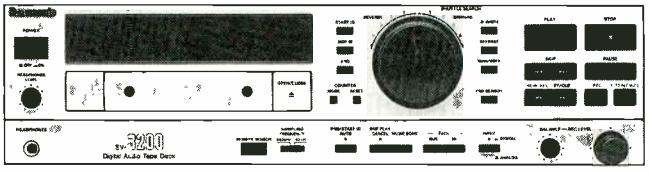
DAT editor

By Sony

• **PCM-E7700:** dual-deck DATStation transportable digital audio editing system; uses non-destructive editing; all-digital signal processing ensures multigenerational integrity; other features include confidence monitoring, simple cuing, tape splice-style graphical editing, analog and digital inputs, ID editing and digital level adjustment.

Circle (397) on Reply Card

Pro DAT machine



By Panasonic

• **SV-3200:** ideal for project studio; features 44.1kHz/48kHz sample rates, 1-bit A/D and D/A converters, a shuttle wheel with dual speed range and high-speed search; when recording via the analog inputs, a front-panel switch permits selection of sampling rate; when recording through the digital inputs, the SV-3200 clocks to incoming frequencies of 32kHz, 44.1kHz or 48kHz; IEC 958 consumer format digital inputs and outputs provide interfacing with CD players, DAW workstations in a recording studio production facility; multi-informational display with error rates, infrared wireless remote control, digital fade-in/fade-out, a software-controlled transport server, amorphous/ferrite composite heads and coaxial/optical digital input selector.

Circle (398) on Reply Card

Digital recorder

By Studer Editech

• **D827-48 digital recorder:** features enhanced servo control; new generation A/D converters provide 18-bit performance, yet retain full compatibility with the DASH format; offers 24 to 48 tracks; available in digital-only configuration; allows all audio interfaces to be fitted at the same time: A/D and D/A converters, AES/EBU and SDIF.

Circle (399) on Reply Card

Other New Products

Digital automation compositing effects

By KUB Systems

• **DANCE:** manipulates and composites multiple static images and live video inputs simultaneously in 3-D space at full resolution and in real time; integrated, one-pass solution makes building complex effects easy and efficient; simplifies post-production process of animating, compositing and creating effects in the post-production, broadcast and corporate-industrial markets.

Circle (350) on Reply Card

Plug-in board

By Spectral

• **Q-Card:** DSP accelerator for Spectral's SynthEngine DSP product; boosts SynthEngine DSP 900% from 20 MIPS to 180 MIPS; plug-in DSP board can be used in Windows-based PCs as

Continued on page 68

Power line protection systems

Clean power is no accident.

By Curtis Chan

The Bottom Line

Today's sophisticated electronic equipment has a low tolerance for power line problems. Power line spikes can damage equipment and corrupt data. Quality power line protection ensures that your equipment will be safe from power line problems.

$

Facility power problems can be difficult to identify and solve. Today's complex electronics systems require protection of the equipment and also the valuable data within. Although many of the problems seem similar, the solutions may be completely different. Deciding on the correct way to defend equipment against power surges, brownouts, noisy lines, EMI/RFI and a variety of other problems has become increasingly difficult. Another problem is connection to other systems through data lines. One positive aspect is the variety of cures ranging from inexpensive to expensive with power ratings from several hundred watts to tens of thousands of kilowatts.

Great things come in small packages

Power line problems and protection systems come in several categories. Solutions come in the form of surge protection circuits for controlling surges between 800V to 6,000V and uninterruptible power supplies (UPS) for protection against brownouts and blackouts. In addition, there are standby power systems (SPS) that combine battery backup with surge suppression, line conditioners that provide tight voltage control and regulation, and line filters to regulate electronic noise. In most cases, one or more of these devices are used to safeguard equipment.

For instance, if equipment overheats and bulbs burn out, it could be caused by the local utility having regulation swells. One cure would be a regulation transformer. On the other hand, if computer systems lock up or lose data, suspect power line sags because of load switching or large amounts of noise/EMI/RFI from local transmitters or power line arcs. In this case, try a UPS along with line

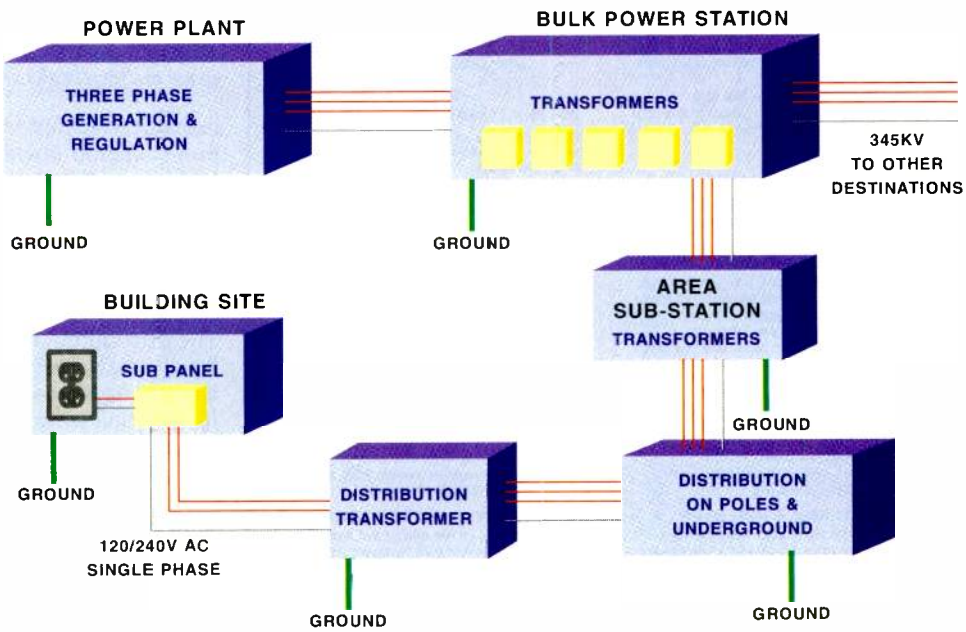


Figure 1. Block diagram of how power gets from the generating station to the load.

Chan is principal of Chan and Associates, a marketing consulting service for audio, broadcast and post-production, Fullerton, CA.

filters or move more sensitive equipment to a dedicated line and use an isolation transformer.

In more critical areas, such as LAN environments, system timing anomalies could be caused by power line harmonics. Data driver and receiver damage along with data loss could be the result of transients on the power lines. The solutions to these problems are more complex. In these cases, computer power and data line monitoring, K-factor analysis and a judicious use of filters, surge suppressors and isolated data lines may be the only viable solution. Finally, for data problems because of grounding, the cause may be due to different ground reference points. In this case, after analyzing common mode ground currents and possible code violations, one solution might be a zero impedance reference grid coupled with isolated data lines and suppressors.

The source of power

To understand the problems, let's look at how power travels from the main generating plant to your facility. Figure 1 shows a typical 3-phase, 4-wire system in which the three hot lines and one neutral line all carry electricity, the current returns through the neutral line. Power plant generators produce electricity (usually 20kV), which is then regulated and sent to a bulk power station. At the bulk power station, a regulator attempts to

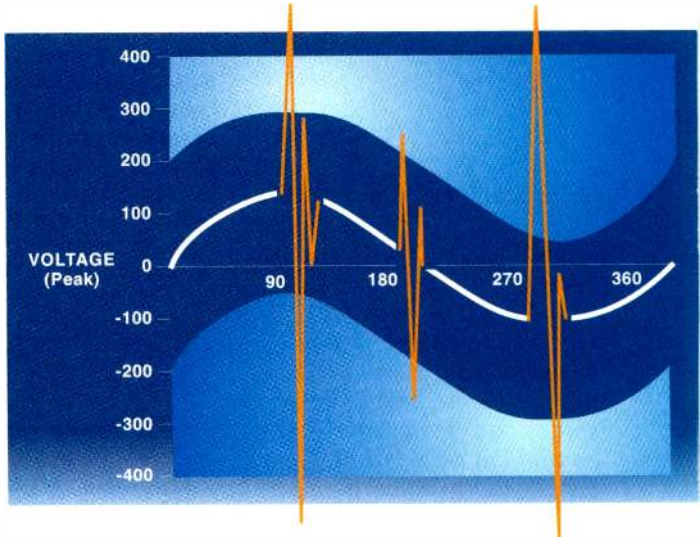


Figure 2. *This graph shows the difference between envelope devices and sine wave tracking devices. Envelope devices clamp at the ±400V level. Sine wave tracking devices clamp within 200V of the AC wave.*

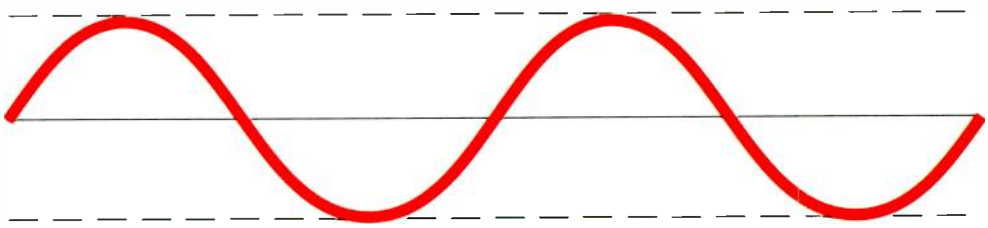
maintain constant voltage but swells and sags occur. The bulk power station boosts the voltage to 345kV for distribution or 138kV for substations. At each point, the system is grounded and some form of surge suppression is used. From there, the area substation reduces the voltage to approximately 15kV, where it is sent to distribution transformers in neighborhoods and service areas.

Noise and transients can occur anywhere along these paths. The distribution transformer reduces the voltage to 120VAC or 220-240VAC (RMS values, for peak values multiply by 1.414), where it is then sent to the facility. Considering that electrical distribution wiring is a metal web that can attract a variety of power and noise anomalies, it's no wonder power sags, spikes, harmonic aberrations and noise can occur. In general, power disturbances fall into three categories: noise, overvoltage and undervoltage.

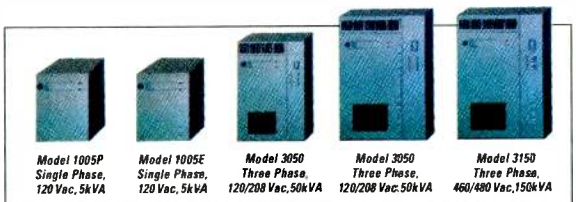
Surge suppressors

There are two kinds of surge suppressors: envelope or threshold clamping devices and sine wave tracking devices. Most surge

Introducing our new product line.



Power industry experts are now pointing to *harmonics* as the main cause of power quality problems which cost businesses millions of dollars a year. Unfortunately, traditional solutions to power quality problems such as UPSs, Line Conditioners and Passive Filters do not adequately address this growing harmonics problem.



The SureSine product line provides clean, reliable power for virtually any application.

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suppressors are envelope devices that use only solid-state protective components, such as metal oxide varistors or silicon avalanche diodes. These devices operate by limiting (clamping) the voltage across their terminals. The clamping voltage depends on the transient current and wave shape and has to be chosen so it doesn't interfere with normal operation. Most good suppressors incorporate several stages of protection.

A first-class suppressor system may incorporate, in series, either gas tubes or high-power MOVs to handle transient currents in the first stage. The second stage might comprise MOVs fitted to each line mode — line to neutral, line to ground and neutral to ground. Finally, silicon avalanche diodes may be incorporated to control the first nanoseconds of a surge. Also, inductors may be used between stages to further isolate each stage.

Although single component suppressors give some degree of protection, they are not always sufficient when applied to an AC supply. One reason is that the suppressor establishes its clamping voltage irrespective of the instantaneous sine wave voltage. (See Figure 2.) Because the clamping barrier is fixed with respect to the neutral or ground point of the AC wave, most single component devices will clamp the transient to approximately 400V peak.

Because the single component suppressor sets up a uniform damping envelope, the damping point varies considerably from the instantaneous sine wave voltage, depending on the phase angle that the transient occurs. For example, an envelope device that clamps at 400V peak would let an additional 230 peak volts through to the load for a positive transient occurring at 90°. For the positive transient occurring at 180°, the same suppressor would let 400V through and, at 270°, would result in an additional 570 peak volts.

Envelope clamping suppressors are effective at preventing transient damage to simple devices, such as motors, but less effective for low-voltage supplies, sensitive electronics or computers. It's been shown that 0.1% to 2% of the surge voltage on the AC input can appear on the DC bus serving sensitive electronic circuits. Switched mode power supplies are less effective than linear power supplies, with typically 1% of the transient feeding through, and smoothing caps don't always do an adequate job. Therefore, using envelope clamping suppressors on the AC line might only limit the transient surge to 570V above the sine wave, resulting in a 5.7V surge on the DC bus; enough to cause physical damage to the ICs.

In most cases, one or more of these devices are used to safeguard equipment.

The answer to this problem comes in the form of sine wave tracking suppressors. These circuits use hybrid filter/suppressor circuits to attenuate high-frequency transients at whatever phase angle they occur. The result is better clamping levels than older threshold clamping devices. The best sine wave tracking suppressors can attenuate an ANSI C62.41 6kV Category A ring-wave to within a few tens of volts of the sine wave.

Putting surge suppression to practical use

Assume that your facility has among its equipment a complement of computer networks. Furthermore, the worst-case scenario assumes your facility is in a high potential storm area where lightning discharges are frequent. In most cases, lightning flashes consist of two or three strokes, each separated by approximately 1/20 of a second. The stroke currents fall in the range of 10k to 100k amps with durations lasting less than one second. The lightning ground flashes affect low-voltage AC power systems by either a direct strike, injecting large impulse currents into the system, or through an indirect strike, inducting moderate currents and voltages on the power line. The best solution is a step-by-step approach. (See Figure 3.)

The first line of defense is a distribution class lightning arrester connected between each phase of the incoming power line and service entrance ground. Although these units can divert large amounts of current to ground, they only provide marginal protection to sensitive electronic equipment.

Lightning arresters should be

Continued on page 60

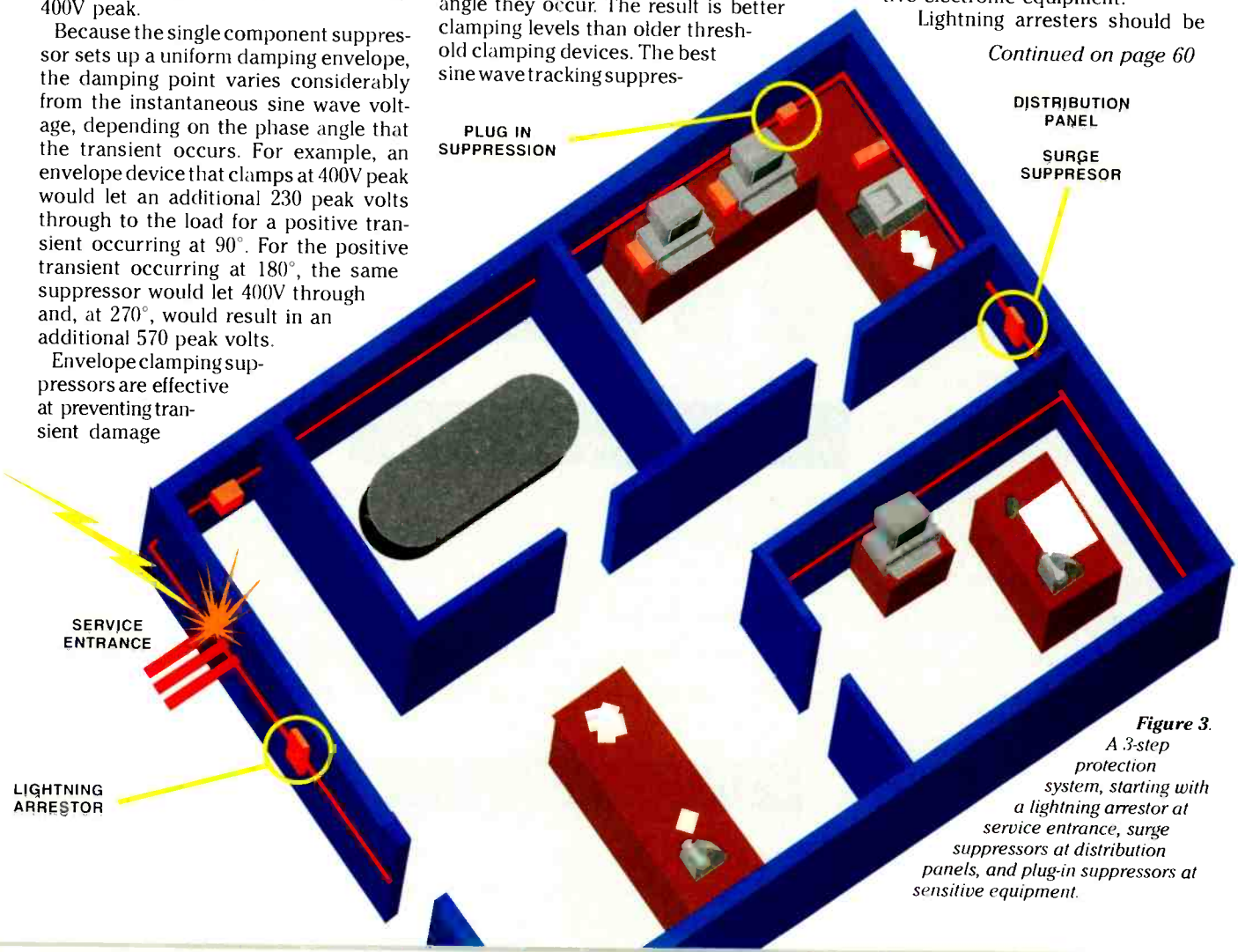

Figure 3. *A 3-step protection system, starting with a lightning arrestor at service entrance, surge suppressors at distribution panels, and plug-in suppressors at sensitive equipment.*

Sizing protection systems

By Steve Epstein, technical editor

One fundamental question in planning for the power requirements of computer and other electronic equipment concerns the size of the power protection system. Power ratings of equipment can be obtained from the site installation/planning representative, the equipment name plate or the equipment manufacturer. Depending on the source, the basic information may exist in any number of forms. Additional calculations may be required to convert this information into kilovolt-amperes, which are the units in which power protection system capacity is measured.

The following symbols are used in the system sizing formulas:

V = volts
A = amps
kW = kilowatt
pf =power factor
kVA = kilovolt-amperes
• ="multiplied by"
$\sqrt{3}$ = square root of 3

Determining kVA

If the total system kW is given, the required power protection system size in kVA can be calculated easily. The basic relationship between kW and kVA is:

$$kVA = \frac{kW}{pf}$$

Power factors of sensitive electronic loads vary from 0.65 to 0.95. If the power factor is not given, a typical power factor of 0.80 may be assumed.

Buyers often will state there is a certain size (such as 200A) feeding an area. This means that the wiring and circuit protection are sized for 200A. When the power conditioner is sized based on the ampere service, one assumption is present service is the correct size for present and future requirements, and the full-load current of the power protection system must match the service size.

To determine the kVA from entrance service amperes, the system voltage must be known. Computer equipment uses power from a 208/120V wye-connected 3-phase system. The formula for calculating kVA from this information is:

$$kVA = \frac{V \bullet A \bullet \sqrt{3}}{1{,}000}$$

Note: V = volts line-to-line. (208V for a 208/120V service.)

In most installations, sizing the power conditioner output to existing service requires a larger service size for the input to the power protection system. This is because of the added load of the conditioner. Additionally, the National Electric Code requires power feeders be sized for 125% of the connected load.

It also is possible to estimate the required size of power protection equipment in kVA if the heat output of each connected device is known. The heat output in BTU/hr for each device can be added regardless of the equipment operating voltage. BTU/hr can be converted to kW by using this formula:

$$kW = \frac{BTU/hr}{3{,}413}$$

Perform this calculation to find the kW for each connected device, then add the results to get the total kW value for all connected devices. Once the total kW value is known, kVA can be determined using the first formula.

An estimate of the kVA load can be made by adding the kVA specifications of the individual loads. If equipment specifications are given in amperes, then the kVA can be calculated with the following formulas. The currents used in the equations are the equipment running/steady-state currents, not the surge current, inrush current or circuit-breaker rating.

For 3-phase systems:

$$kVA = \frac{V \bullet A \bullet \sqrt{3}}{1{,}000}$$

For single-phase systems:

$$kVA = \frac{V \bullet A}{1{,}000}$$

Note: Simply adding the kVA values may result in an erroneous estimate of the total kVA draw of the system, particularly for unbalanced loading conditions. A more accurate estimate of the required kVA size for the power protection system can be made by balancing the equipment on the phases, then determining the required system kVA from the phase with the largest load.

Some power protection systems are rated in terms of both kVA and kW. With these systems neither load limit can be safely exceeded. Other considerations affecting power protection system sizing include the existence of pulsing heavy inrush loads. Loads that are highly nonlinear may require oversizing. In these cases, consult the manufacturer of the power protection equipment for more detailed sizing guidance.

Planning for growth

Accurate estimates of system growth requirements are difficult. Most efforts in this area are better classed as "guesstimates," but there are some general guidelines that can be helpful. The power protection system should be sized to anticipate growth to protect against short-term obsolescence. The time it takes to double the present power needs can be estimated using the following relationship:

$$T = \frac{72}{R}$$

Where T= time to double in size
R= growth rate in %/unit time

For example, if growth is 4% per month:

$$T = \frac{72}{4\%/month} = 18 \text{ months}$$

As these examples indicate, the growth rates commonly associated with computers and other electronic equipment means power requirements double in a relatively short time. Therefore, it is not unreasonable to size the conditioner for twice the present estimated kVA load. Even in a minimum growth environment the conditioner should be sized for 125% of estimated kVA load. The added initial and operating costs of using a larger-capacity system are small when compared to the engineering, acquisition and installation costs of an additional power protection system at a later time.

Acknowledgment: This information is based on a paper by the Leibert Corporation.

Continued from page 58

separated from surge suppressors by an adequate distance to be effective. Typical minimum distances are approximately 10 feet between the arrester and the panel suppressor. Why? Because lightning arresters have a high turn-on voltage (1.5kV-3.5kV) that may prevent them from ever conducting, the turn-on voltage of a panel suppressor is much lower.

The second line of defense is additional surge suppressors mounted on distribution panels serving sensitive equipment.

There are two kinds of surge suppressors: envelope or threshold clamping devices and sine wave tracking devices.

Finally, use a hard-wired or plug-in surge suppressor at the point of connection to the equipment. Well-placed suppressors at either end of a facility also will add to the protection level.

Specifically, suppressors at a breaker panel and another one placed at the load will give added performance because the inductance of the wire between the two suppressors improves the overall performance. Similarly, a network consisting of suppression devices on the primary and secondary of the line transformer can be made. Coupling is done by the inductance in the windings.

Last, don't forget there are data line conditioners for trapping line transients. The reality of transient energy is complex. Energy that finds its way in between two suppression components separated by inductance, bounces back and forth until it either escapes or dissipates into other forms of energy. Some energy is conducted onto the neutral or ground conductors. Some of the energy is changed into EMI while some continues down the line.

UPS

The last line of defense against power disturbances is the use of tried and true UPS devices. The uninterruptible power supply is like fire or life insurance: Once needed, if you don't have it, it's too late. These devices usually can be found in power increments ranging from several hundred VA to more than 5kVA. Newer systems also offer stackable units that can be ganged together to supply higher throughput and backup time. No matter what the system, UPS devices offer users peace of mind and security from the majority of power problems plaguing equipment. For computer users, network environments and mission critical uses, UPS devices are a must and a godsend.

UPS features

Like all vertical market products, UPS devices come in a variety of sizes and features. Some UPS systems are nothing more than standby power systems. These systems do not have true no-break power and are simply masquerading as UPS systems. First, make sure the battery is easily replaced and economical. Battery failure usually occurs in the first three to four years depending upon use. Be sure the UPS has true sine wave or modified sine output. Although PC power supplies are tolerant of short interruptions and out-of-bounds power anomalies, they don't like square wave outputs.

Sine wave and step-sine wave UPS devices deliver proper peak and rms values to your loads, but square wave units deliver peak and rms values that are equal to each other. This can cause premature component failure by alternately starving the computer with a peak value that's too low and force feeding it an rms value that's too high. Lower-priced models without microprocessor intelligence usually have the step sine wave output.

Make sure the UPS has boost output regulation. This is important because the power line may drop to as low as 88VAC. If this happens, the UPS should be able to boost voltage without depleting its batteries. Even moderately priced UPS systems have built-in alarms that in some cases are programmable. These include low backup time, overload, replace battery, high temperature, low battery and site wiring fault. Some newer models come with external environment sensing and monitoring units. These units monitor and warn of extremes in humidity and temperature and usually have contact closures for external devices that detect smoke, fire, water and security problems.

The best sine wave tracking suppressors can attenuate an ANSI C62.41 6kV Category A ring-wave to within a few tens of volts of the sine wave.

UPS systems also should include some form of surge and noise suppression. This function can be internal or a part of an external surge suppression device. Another feature to look for is a UPS with inverter shutdown. Without inverter shutdown, the UPS will continue to run until its batteries are depleted. In that case, the unit may not be prepared to respond to multiple outages occurring only a few hours apart. Smarter UPS systems employ battery monitoring devices capable of predicting working time available. Many units dynamically adjust for changes in load and battery condition.

For LAN environments, most UPS devices have interfaces and software available for a variety of purposes. This permits the UPS to go on-line and allows network power management of non-manageable hubs, peripherals, PBX and security systems on a single serial port. Software specific to UPS systems also control, monitor and analyze power. This allows the triggering of events at predefined or periodic intervals, giving a log and history on various power disturbances. UPS suppliers also promise simple network management protocol (SNMP) support if it's standardized.

The SNMP came about to meet the need for a common language for the management of large, multivendor networks. Until a standard management information base is completed, however, each vendor's solution is proprietary.

Moving further upscale, many UPS systems offer a remote monitoring and control system for UPS load and temperature, battery condition, charge and up time, outlet ground and polarity, and surge monitoring. Beyond that, some UPS devices have built-in AC and protection diagnostics in the form or indicators, sounds or displayed outputs via an interface. In this case, it's also possible to customize your window of safe shutdown time. The last two items on your list should be how long has the company been in business and the depth of its warranty coverage. Make sure to check for accidents, fire, lightning, liquid spills and internal damage.

You can never have too much protection for your equipment. For naysayers who put their full faith in our power utility companies, ask yourself how much your critical data is worth. Investing in power line protection is worth every penny. It will pay for itself during the next power surge or brownout...guaranteed.

Editor's note: The author would like to thank James Phillips of Surge Suppression Devices and Bruce Stonely of EFI Electronics Corporation, as well as Best Power Technology and APC, for their help with this article. ■

➡ *For more information on power protection, circle (310) on the Reply Card. Also see "Power Line Conditioners" on p. 28 of the BE Buyers Guide.*

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Applied Technology

Fuji's Super Double-Coating process

By James Hegadorn

Developers of magnetic media have long realized that in order to fully reach the theoretical limit of recording on tape, they had to perfect several key technologies. Specifically, these pursuits include: 1) the development of metal particles with smaller, more uniform shape and higher energy potential; 2) thinner, more highly packed formulations with tough durable binding systems; 3) super-smooth coating surfaces; and 4) thin, durable base films. These elements are all necessary to increase recording times and improve the recovery or playback of information from tape formats that are using more complex, shorter wavelength digital recording schemes.

Recording media have evolved into highly specialized products with most, if not all, of their technological advances stemming from development work in the broadcast and data recording industries. As these technologies become more mature and their cost factors decrease, they generally trickle down into the home recording and entertainment marketplace. One such technology known as *double coating* has led to an evolutionary improvement called *super double coating*, which stretches the performance characteristics of a mature format using current manufacturing technology.

Media through the years

In order to understand the reasons for this trend in media, a brief historical overview is in order. Improvements in recording media have traditionally stimulated recorder manufacturers to develop head design and formats that take increased advantage of the media's new properties. To wit, 2-inch hi-band video yielded to the 1-inch designs *Type A* and *Type B*, with *Type C* finally winning the format war. In 1969, the *U-matic* format, a 3/4-inch cassette system, was introduced, followed by the 1/2-inch cassette formats *VHS, Beta, MI/MII* and *Betacam*. All of these formats used cobalt-modified ferric formulations, and all served their intended purpose. But as each technological jump in hardware occurred, recording media ratcheted performance up another notch.

Experimentation with metal media began in the early 1960s, and as materials, processes and understanding improved, so did the tape. In 1978, metal audiotape was introduced, and manufacturers tried to re-implement an old idea patented in 1949 for applying two coats of formulation to a tape base. This double coating trend in audiotape suffered from low yield and high cost because of the successive (2-pass) coating methods employed.

As a part of its work with metal media and the promise of greater performance, Fuji Photo Film introduced the world's first high-density metal particle (MP) tape at the 1991 NAB Convention. In the last few years, the use of advanced metal particle formulations in such formats as *Betacam SP, MII, D-2, D-3, D-5* and *DCT* has flourished. It's safe to assume future formats will rely on metal tape formulations.

As the use of metal particles in new formats increased, some digital users became concerned over rumors of the particles' inherent instability. These instability issues then had to be addressed by the industry and answered to satisfaction of the user community.

The concerns centered on the reliability of products in archival situations and the potential oxidizing of the metal tape because of harsh environmental conditions and heavy use. The high-powered particles used in metal formulations are processed to provide small, uniform particle shapes, which are covered by a layer of thin oxide crystals. This layer of oxide gives the particles protection against any corrosive agents that might contact the tape in normal use. Performance of these formulations in the intervening years has soothed any remaining user anxieties.

Another important factor in the performance of metal tape for digital applications is surface smoothness. The use of small particles that have good dispersion characteristics combined with proper calendaring and finishing techniques have yielded great improvement in surface smoothness. This directly contributes to carrier-to-noise ratio and, ultimately, to error-rate performance.

In an effort to expand upon the applications of metal particle technology for mainstream supply, the industry has experimented for several years with vacuum evaporation of metal alloys for the next generation of advanced, thin-film media. The process yields an extremely pure, high-energy metal layer of magnetic particles whose thickness is measured in angstroms. *Metal evaporation* is still not a mature technology. Although it has shown great promise in its signal performance, it suffers from low manufacturing yields, and the product is sometimes less durable in extreme situations.

Double-coating evolution

Numerous attempts to manufacture media with dual layers were made in the late 1970s and early 1980s. Fuji Photo Film, employing its film-coating expertise, became the first company to successfully coat two layers of magnetic material simultaneously on a single substrate in 1986. This breakthrough was achieved by adapting film-coating techniques to the physical properties of magnetic formulations and by using a unique coating head with two slots or channels. (See Figure 1.)

In 1989, Fuji Photo's Magnetic Products Division introduced a double-coated VHS product. Given that VHS and its evolutionary sister format S-VHS are fixed standards, improvements could be gained only by changing the way the different frequencies of the recording systems performed on tape. The double-coating process allows for the fine-tuning of two different formulations on a single tape base.

The VHS formats use a depth-recording scheme, in which different signals use different layers of the tape. The luminance signal is recorded at 5.4MHz to 7MHz at a wavelength of 0.6μm. These are recorded on the upper layer of the double-coated tape, which uses a fine ferric oxide particle optimized in thickness for this purpose (1.5dB better RF record/playback performance than a conventional single-coat tape). The lower layer uses larger particles that are fine-tuned to the longer wavelength (lower

Hegadorn is technical service manager at the Magnetic Products Division of Fuji Photo Film U.S.A., Elmsford, NY.

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frequency) signals used in VHS for the color-under chroma signal, and both the FM (hi-fi) and standard (longitudinal) audio signals.

Next, the 8mm system was targeted to benefit from the double-coating technique. A hybrid tape system was designed, which employed a thin upper layer of metal particles and lower layer of standard ferric particles, providing superior high-frequency performance. The lower layer's characteristics could now benefit from a standard ferric formulation optimized to the longer wavelength signals used in the audio and color-under signals of the 8mm format.

Subsequently, 8mm also experienced an evolutionary change, producing the Hi8 system. This format was developed around the metal evaporated (ME) tape type. ME allows pure metal alloys, typically cobalt nickel, to be transferred to a tape substrate in a vacuum chamber under bombardment by an electron beam. This pure metal layer of particles achieves extreme-

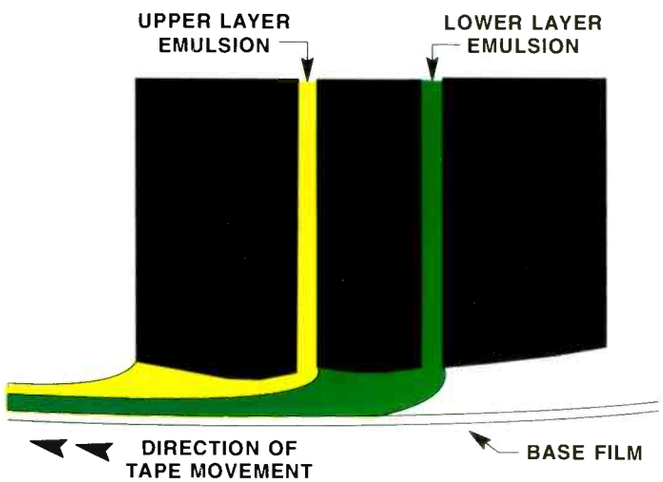


Figure 1. *Cross section of specialized coating head that applies two separate emulsion layers at different depths and thicknesses simultaneously.*

ly high magnetic and electrical performance characteristics because of its lack of oxides, lubricant and binder materials. As a final preparation step, the surface must be treated with a smooth protective coating, which prevents oxidation of the metal layer.

Experimentation on thin-film recording media shows that decreasing the active magnetic layer's thickness will increase the RF output at higher frequencies. Figure 2 shows how digital recording will benefit from this function of increased output vs. decreasing thickness. A remaining problem involves thin films' unproven durability in the professional environments of editing, high-speed search/shuttle, and the adverse ambient conditions of camcorder use.

Super double-coating technology

The newest digital formats are designed around high-density, high-output formulations. One such formulation has evolved from the use of double-coating techniques combined with advanced metal particle coatings. This new concept is called *Advanced super Thin layer and high Output Metal Media* (ATOMM). This technology has been successfully applied in the Hi8 format, using a 0.3μm upper layer of metal particles simultaneously coated over a non-magnetic layer of titanium material. The result is a signal output that is equal to or higher than conventional Hi8 cobalt-nickel ME tapes, or at least 3.0dB greater than previous Hi8 MP formulations. This higher output comes from

an increase in magnetic density up to 40% of formulation volume.

The magnetic layer of this new Hi8 tape has been smoothed to 2.5nm. Typically, standard VHS tapes' magnetic layers measure from 10nm to 20nm. The improved smoothness is made possible by the extremely hard and smooth surface created during simultaneous coating of the minute spherical particles in the titanium layer.

These titanium particles are approximately one-sixth the size of the magnetic metal particles. They actually fill the few imperfections that might be found on the tape base surface, providing a hard, stiff platform for the active magnetic layer. This surface smoothness results in considerably improved head-to-tape contact, and it reduces spacing loss to further increase high-frequency output.

The improved reliability of Hi8 *Super DC*, as this formulation is called, compared to less durable ME tape, is accomplished by using well-established particle coating manufacturing methods. The lower layer offers a strong yet pliant support mechanism for the active upper layer. The upper layer's formulation is able to support a high molecular-weight binder with superior stability characteristics. Most important, all of this can be accomplished with current mass production coating facilities.

Although this new product is an MP formulation, its performance characteristics allow the cassette shell to be configured for ME-position operation. Therefore, the full effect of the Hi8 format's frequency range characteristics can be realized, and the merits of MP and ME technology can be brought together without the compromises of the past.

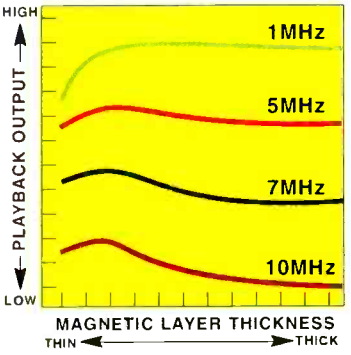


Figure 2. *Output level vs. magnetic layer thickness is plotted at several recording frequencies. Although absolute output level decreases with increasing frequency, thinner recording layers have a beneficial effect on output at higher frequencies. Optimum thickness also varies with frequency.*

The Hi8 application is only one use for this product. JVC, with the support of Matsushita, recently introduced W-VHS, a new home video system capable of recording various high-definition and ATV standards. This system uses a 1/2-inch version of the super double-coated videotape for analog video recording, similar to the Hi8 formulation. The increased recording density offered by super double-coated videotape allows for longer record and play times than would otherwise be possible with this format.

Super DC technology also is being tested as the possible media for a new generation of 20Mbyte floppy disk drives. Other possible applications include digital home recording systems for audio, video-on-demand systems, data back-up for home computers, and mass storage systems for science, business and industry. The future of magnetic recording rests on the development of high-energy, thin-film heads, simple and gentle tape path designs, and the durable performance of thin-coat magnetic media. ■

➡ *For more information on Fuji's Super DC process, circle (307) on Reply Card.*

Field Report

Nikon S15 lens

By Al Saltzman and Michael Crew

The first over-the-air (non-cable) all-news channel in the United States, KNWS-TV in Houston, went on the air in November 1993 using all-Nikon ENG lenses. The Nikon S15 lens was selected after a shootout with three other lenses.

Because the Nikon lens demonstrated a strong low-light capability during the shootout, KNWS plans to eliminate the use of lights for most field assignments. This will reduce the overall weight of the equipment employed, reduce the strain on the field producers, make the field producers more maneuverable and render them less distracting.

KNWS's testing revealed that this lens can produce clear color pictures even in almost total darkness. This was the most significant finding in the lens shootout,

Stories can be assigned with confidence, free from doubts about light conditions or sensitivity of the subject.

and it will have many beneficial consequences for the station's work.

The shootout also revealed that the Nikon lens had the fastest focus, produced the sharpest pictures, had an ergonomic design that reduced strain on the arm during operation, and, surprisingly, was priced lower than any of the other lenses tested.

Field producers' requirements

KNWS uses field producers who work simultaneously as reporters and camera operators. They have been selected from both reporting and video backgrounds. In such an arrangement, operating the camera has to be as easy and fault-free as possible. Equipment has to work easily and well under many varied conditions.

Saltzman is chief engineer and Crew is news director at KNWS-TV, Houston.

Performance at a glance

- *High-quality ENG/EFP lens system*
- *Extreme low-light capability*
- *Designed for ease of use*
- *Lightweight, rugged construction*
- *Provides high versatility*
- *Attractively priced*

As the heart of a camera system, the lens for this application has to be versatile and virtually fault-free. It has to operate at maximum capability under all of the trying conditions that field producers might encounter. The application also calls for an ergonomic design, so that operating the lens does not cause fatigue for the field producers or cramp their muscles (which can happen when the focus ring is not located in the proper spot, for example).

The lens also needs to be lightweight because the field producer is already burdened with a camera, an S-VHS tape deck and battery pack, and sometimes lights with a separate battery pack.

Further requirements are fast focus and refocus without the need for shuffling up and back, zoom that does not distort images, high resolution, and clear, sharp pictures.

Most important, the lens has to function well in low light, when auxiliary lighting is not or cannot be used. This is critical because field producers are visible when they turn on the lights and can become an obtrusive factor in the story being covered. Lights can disturb crowds or they may disclose where the field producer is located when he or she does not want to be noticed. Police also might request that lights not be turned on. In all of these situations, KNWS wants to be sure to still get acceptable video. Low-light capability can be the difference between getting a story or getting left in the dark.

Of course, working without lights enables the solo field producer to work with less encumbrance, and it also cuts down on battery drain.

The shootout

To test for the best lens for our application, KNWS requested a standard 2/3-inch moderate zoom lens from four major suppliers. Three identical cameras were used in the test, all attached to a single bar and pointing at a studio set.

A vertical wipe was used, linking the cameras through a switch so that the images would come up on the monitors in a split-screen format. That way the images could be directly compared visually.

In the first studio tests (in full light) the Nikon S15 proved superior and was used in subsequent tests as the standard for comparison. The crew ran through rack focusing, refocusing, tracking and testing of the focus zone, while observing the sharpness or softness of the images produced. The physical arrangement of controls and ease of use also were compared.

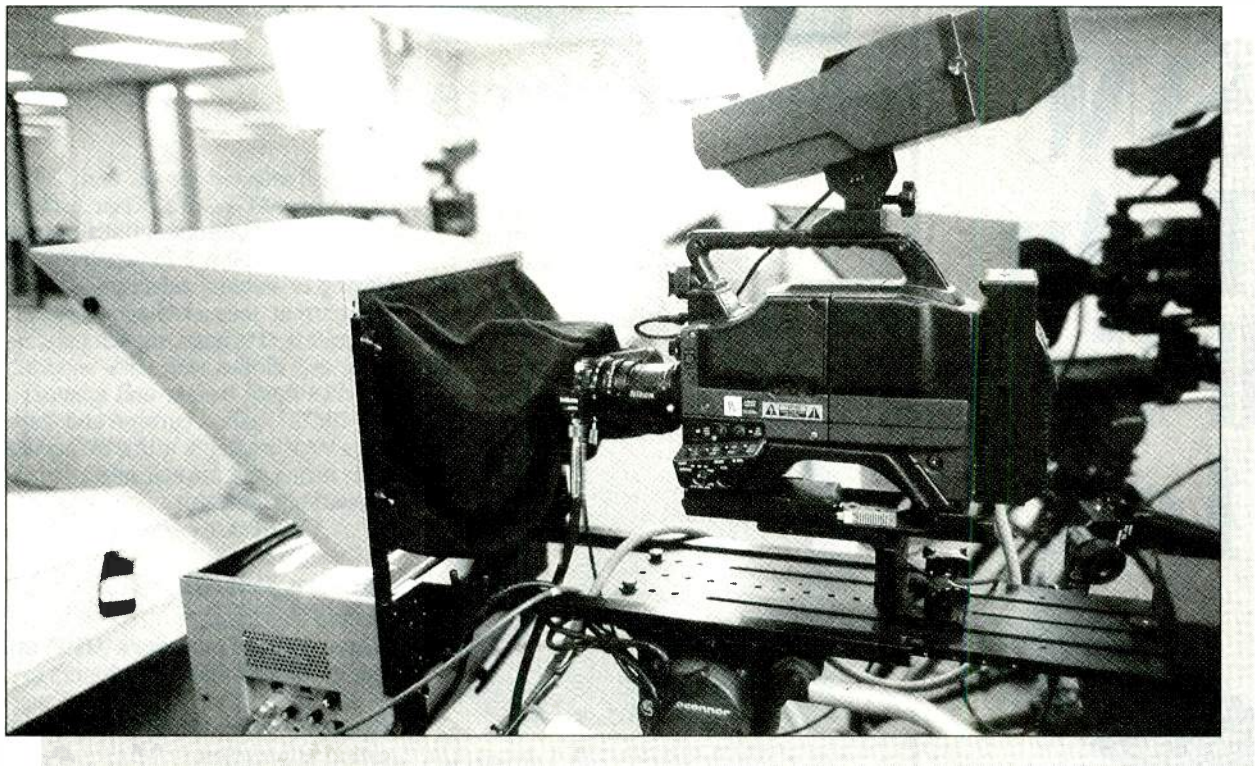
The S15 came out best by a significant

In every way, the S15 is an amazing lens.

margin in all of these tests. The next stage was low light, starting with half light and then a flashlight powered by a AA battery. The Nikon excelled in these tests, too, still producing clear, sharp pictures.

Finally, almost total darkness was established to test the lenses at the absolute margin. Two of the lenses produced no image on the monitor. The blackness of the picture on the monitor could not be discriminated from the blackness in the room. Another lens produced a dim image, showing a faint outline of the set in the shot.

The Nikon S15 showed the set clearly, even in near total darkness. KNWS engineers still don't know exactly how this is accomplished, but it represents an advance in optics technology of great potential significance. To confirm this impressive finding, the same S15 lens was mounted successively onto each of the three cameras to verify that the camera



Shootout at the KNWS corral. The Nikon S15 lens mounted on a camera and ready for testing in the KNWS studio.

was not the determining factor. It wasn't.

The S15 lens also was a full pound lighter than the next lightest lens and about half the weight of the two others. As a result of these tests, KNWS decided to purchase nine S15s and one S19 for sports events.

Next came the pleasant surprise of pricing. While it was the ablest of all the lenses tested, the S15 also cost the least — another unsolved mystery for the KNWS staff.

S15 details

The S15x8.5B lens is one of three Nikon ENG/EFP lenses specially designed for use with ⅔-inch CCD cameras. The others are the S19x8 lens and the S9x5.5, a wide-angle lens.

The S15 has a 15x zoom ratio, minimum focal length of 8.5mm, a built-in 2x extender, focal length of 8.5mm to 255mm (with extender), effective picture size of 8.8mm x 6.6mm, maximum relative aperture of 1:1.7 (f = 8.5mm to 8.7mm); and minimum object distance (MOD) of 0.8mm.

The S15 weighs only 1.25kg. The light weight derives in part from a unique integration of the servo and extender sections and Nikon's extra-low dispersion (ED) glass.

The glass produces faithful color rendition and minimal tracking registration errors. To enhance light transmission and eliminate ghost images, the lens employs layers of a special anti-reflection coating.

New possibilities

Not needing lights means that something like the Rodney King video could have been shot unobtrusively, as it was, but in clear, broadcast-quality color images. This ability means that KNWS will be able to photograph many more types of situations that were never possible before. Such stories can be assigned with confidence, free from doubts about light conditions or sensitivity of the subject.

In every way, the S15 is an amazing lens. In years of buying lenses, KNWS engineers have not encountered its equal. It will make a major contribution to KNWS's success as an all-news channel. ■

Editor's note: Field Reports are an exclusive *BE* feature for broadcasters. Each report is prepared by the staff of a broadcast station, production facility or consulting company.

These reports are performed by the industry and for the industry. Manufacturer's support is limited to providing loan equipment and to aiding the author if requested.

It is the responsibility of *Broadcast Engineering* to publish the results of any device tested, positive or negative. No report should be considered an endorsement or disapproval by *Broadcast Engineering* magazine.

New Products

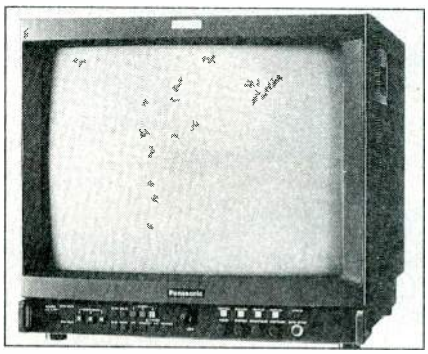
Continued from page 54

a stand-alone DSP system or as part of Spectral's AudioEngine DAW system.

Circle (351) on Reply Card

All-digital broadcast monitor

By Panasonic



• **AT-H1905D:** industry's first digital processing professional broadcast monitor; 19-inch color monitor; features complete digital signal processing for composite analog and digital signals to maintain high-quality images; offers digital luminance/chrominance separation via a 5-line digital comb filter to reduce dot crawl on edge transitions; monitor is capable of four direct digital interfaces: serial composite and component, and parallel composite and component; monitor has a pulse-cross function for displaying horizontal and vertical blanking, even from digital signal sources; serial interface features an error-detection and handling check function to warn operator of potential signal failures.

Circle (352) on Reply Card

Digital multimeters

By Tektronix

• **DM255, DM256 and DM257:** general-purpose multimeters designed and manufactured to comply with safety standards established by UL and IEC, and conform to MIL-T-28800, Class 2 standard for shock and vibration; DM255 features a 3½-inch display, 0.7% accuracy, autoranging or manual selection, data hold and current measurements; DM256 offers testing of voltage, capacitance, resistance and diodes with 0.5% accuracy, a fast continuity beeper and memory offset; DM257 offers current and capacitance measurements with 0.5% accuracy, autoranging and manual selection, and a low-battery indicator.

Circle (353) on Reply Card

Software package

By Avid Technology

• **Open Media Framework (OMF) Interchange toolkit:** allows developers to easily add support for OMF Interchange to any digital audio, video, graphics or animation application.

Circle (354) on Reply Card

Serial digital router

By Dynair

• **Digital X:** 16x8 serial digital routing switcher; first digital router available with a fiber-optic input and output option; automatic signal EQ and reconstruction at each input ensure proper data recovery when using up to 300 meters of low-loss Belden 8281 or equivalent cable; optical fiber can be used for greater distances; because no reclocking circuitry is used, the router operates on all currently accepted data rates up to 405Mb/s.

Circle (355) on Reply Card

Interface

By Dynatech

• **NewsWare:** interface between the NewStar II newsroom automation system and the DigiStore tapeless storage device.

Circle (356) on Reply Card

New Products

Digital audio delivery system
By Enco

• **DAD486x:** powerful DOS-based digital audio system developed for broadcast and other fixed location audio applications; based on standard Intel 486/50 computer hardware; can be used as either a stand-alone workstation or large multiple workstation configuration operating on a LAN; features a comprehensive GUI that is familiar to traditional broadcast equipment operators and touch-screen control; provides complete multi-play, record, waveform editing and library maintenance functions for live-assist, automated or satellite-programmed operations.

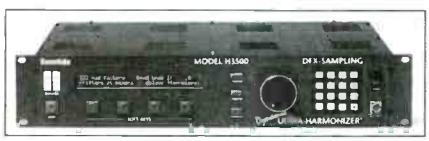
Circle (357) on Reply Card

RF radiation area monitors
By Loral Microwave-Narda

• **SMARTS models 8810/8815/8820/8825:** cover wide frequency bands from 2MHz to 44GHz; feature audible, visual and electronic alarms; provide continuous detection of RF radiation within a specific area; 8810 monitors the common 2-30MHz HF band and is shaped to the new IEE C95.1-1991 Standard for human exposure to non-ionizing radiation; 8815 monitors emissions from 10-500MHz; 8820 and 8825 cover the 0.5-18GHz or 44GHz bands, respectively; three similar outdoor models (8810-WP, 8815-WP and 8820-WP) cover the 2MHz to 18GHz frequency range.

Circle (358) on Reply Card

Special effects processor
By Eventide



• **H3500-B Dynamic Ultra-Harmonizer:** contains all the highlights of the original H3500, plus the broadcast extras that make the H3000-B a powerful tool for radio and TV professionals; features the benefits and programs of an H3000-SE; includes up to 95 seconds of digital sampling, plus the Mod Factory algorithms, which add dynamics, gating, ducking, ompression and more than 100 new presets.

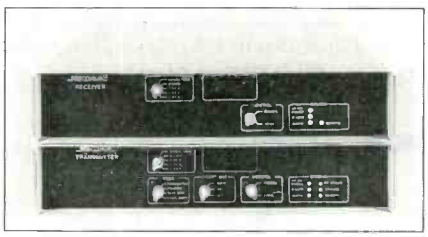
Circle (359) on Reply Card

Rigid transmission line
By Dielectric

• **digiTLine**: only rigid transmission line that will work with NTSC, HDTV or both; can be used with any channel; features broadband UHF, VHF and FM; high-power handling/high efficiency; installed and maintained like standard rigid line; available in $3^1/_8$", $4^1/_6$", $6^1/_8$": and $8^3/_{16}$" sizes.

Circle (360) on Reply Card

Transmitter/receiver systems



By Nucomm

• **AT/AR4 series:** rack-mountable, agile, dual-conversion, IF heterodyne, microwave transmitter and receiver systems; radios cover the 2, 2.5, 6-7, 12-13GHz bands as well as military and international frequency bands; accommodates a 70MHz interface to other video and audio systems for transmit/receive terminals or baseband drop and insert functions; ideal for STL/IRC, multihop, multichannel

New Products

broadcast, CATV and ETV video systems networks and emergency restoration applications; can be configured for simplex or duplex operations; fault alarm detection and system diagnostic circuits are included with each transmitter and receiver.

Circle (361) on Reply Card

Software upgrade

By Imagine Products

• **Executive Producer:** productivity software for use with the Abekas Video Systems A34 Solo editor; enhanced to read and produce Solo A34 edit decision lists, giving users powerful list management and EDL conversion capabilities; key features are the added support of mixed (drop and non-drop frame) NTSC source material and multiple EDL formats.

Circle (362) on Reply Card

Central receiver

By Nucomm

• **20CR4 series:** covers the 2GHz and/or 2.5GHz bands or the full band between 1.99GHz to 2.7GHz, which can accommodate a blockdown converter; other frequency bands are available; 2dB noise figure; HF 70MHz composite and baseband output are offered; up to four programmable audio subcarriers are available. 11-32VDC, 90-260VAC, 40-400Hz operating range.

Circle (363) on Reply Card

Monitoring equipment

By Trilogy Broadcast

• **Transmission, video, audio, signal line monitoring equipment:** for satellite and terrestrial television; product line includes models for video, pulse, audio and Nicam distribution equipment; video and sync detectors; audio modulation; audio pilot tone generators and detectors at different frequencies; video phase comparators; audio and video 2x2x1 relay changeover and custom modules; individual modules fit into 1U or 3U frames.

Circle (364) on Reply Card

Software

By ETI

• **Cooperative Communications:** adds manifolding capability for two or more ADH-2COM waveguide dehydrators; one dehydrator pressurizes while the second is held steady; dehydrators communicate with each other through their RS-422 serial communications ports; provides reliable pressurization for a wide variety of abnormal operating conditions, including loss of power to one of the dehydrators.

Circle (365) on Reply Card

Distribution amplifiers

By Matthey Electronics

• **2500 series:** provides a DA and delay DA on each card; features loopthrough and up to eight outputs; offers front-panel adjustment of gain and cable equalization; cards are contained in a 3U rack frame that has been specially designed to reduce all modes of vibration; RFA rack

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Continued from page 30

HD in the United Kingdom

By H. A. Cole, CEng., MIEE

In Britain today, 44 UHF channels, employing 1,000 terrestrial transmitters, are used to broadcast four separate TV programs, reaching 99.4% of the country's 56 million population. A fifth program may come on-line, which would occupy two more channels.

It has been calculated that an all-digital TV system could transmit these five programs in the UHF band. This could be done using as few as 10 channels, which would free valuable spectrum space for other uses, including additional programs, enhanced definition and different-sized pictures.

Of course, this implies massive equipment conversion for broadcasters, program producers and consumers, comparable to 1967, when Britain switched from its 405-line monochrome standard to the 625-line PAL color standard. That switchover was not an abrupt transition, and for many years programs were simultaneously transmitted on both standards. The same thing will have to happen with the introduction of a digital TV standard, involving a gradual phase-out of 625-line PAL.

In Britain, both the British Broadcasting Corporation (BBC) and National Transcommunications Ltd. (NTL) — in some cases working separately, in others as partners with European collaborators — are currently active in many HDTV research projects.

Eureka-95

All TV systems in use throughout Europe are based on a 625-line system (either PAL or SECAM), using 50 interlaced fields per second (fps) and a 4:3 aspect ratio. Similar to NTSC, on larger TV screens the horizontal scanning lines (and the attendant loss of resolution) are clearly visible, PAL/SECAM's 100 additional lines notwithstanding. Worse than NTSC is a noticeable flicker from the 50fps rate.

Eureka-95 is a European analog HDTV research project that began in 1986, and its charge is to overcome all previously mentioned drawbacks. The project's proposed format doubles the number of scanning lines to 1,250 and increases the aspect ratio to a 16:9 format.

The problem of flicker is overcome by doubling the field refresh rate on HDTV receivers by use of internal circuitry, meanwhile retaining the 50fps refresh rate on the transmitted signal so that traditional (non-HDTV) receivers can still display the picture. When a standard television receives an HDTV signal, however, the reproduced picture will be displayed in letterbox format with black borders at the top and bottom because of the differences in aspect ratio.

The BBC is one of more than 60 partners in Eureka-95. It has made fundamental contributions to the system, particularly in devising a technique that allows the compression of the HDTV broadcast signal by a factor of four. Thus, it can be transmitted over a standard DBS channel.

Although a few European DBS services now exist using multiplexed analog component (MAC) technology (including the original Eureka-95 plan), others have embraced different standards. Most of these non-MAC systems take the direction of "enhanced PAL," such as PAL Plus, a progressive scan, 16:9, 625-line format. The debate continues throughout Europe as other countries consider fully digital HDTV services. As a result, Eureka-95 HDTV services probably will not begin in 1995 as planned, but somewhat later, at which point digital, rather than MAC technology, may be ultimately employed.

SPECTRE

A research and development project known as SPECTRE (Special Purpose Extra Channels for Terrestrial Radiocommunications) was started in 1988 to study potential techniques for better use of the current UHF broadcasting band by using modern modulation techniques. Since then, the aims of the project have been redirected into proving the feasibility of a digital terrestrial TV broadcasting system. This is being done under the auspices of NTL, working under contract to the Independent Television Commission (ITC, the licensing and regulatory body for commercial television in Britain).

Recent field trials of SPECTRE hardware have taken place at two NTL TV transmitter sites in southwest England. These tests represent the first live demonstration of pictures through the SPECTRE project. In the first test, one of the transmitters broadcasts a full digital TV signal while the other (50km away) served as an interference source. The test demonstrated the robustness of the modulation scheme OFDM (Orthogonal Frequency Division Multiplexing). Test transmissions also were made from each site across a range of taboo channels to further assess effects of interference.

Future issues

In the context of such digital experiments, British broadcasters are now leaning strongly toward a future HDTV standard that will embrace a fully digital standard.

Among other matters yet to be resolved is the diversity within the European TV market. Currently, it requires manufacturers to build dozens of different variants of each TV model to meet the different standards and requirements of the continent's several countries. (For example, one manufacturer currently makes 90 different versions of a high-end TV receiver fitted with stereo audio for European distribution.)

A future pan-European HDTV standard could minimize these wide-ranging differences and work nicely into the European Community (EC) movement. However, the EC recently opted against allocating substantial funding for HDTV standardization, and the current positions of many European HDTV players remain widely separated.

Cole is a freelance writer on electronic engineering, and is based in the United Kingdom.

tenders include Amati, AT&T, USA Digital, Thomson Consumer Electronics (Eureka 147) and NASA/VOA. Meanwhile, the NAB has asked the FCC to reject satellite DAB applications now pending as premature. Remaining contenders in taht forum are CD Radio, Digital Broadcast Satellite Corporation, American Mobile Satellite Corporation and Primosphere. (See "re: Radio," p.12)

The chairmanship of the FCC was handed over to interim commissioner James Quello when Alfred Sikes resigned in January. Noting that a major problem of the FCC is it's reactive nature, Sikes cited important upcoming issues, including HDTV, personal communications services andlow-earth-orbit satellites. One regret: Sikes had wanted a larger penalty in the Howard Stern indecency pleading.

Waiting in the wings is FCC chairman designate Reed Hundt, who, at press time, had completed hearings before the Senate Commerce Committee. He is expected to be in place early in the new year. His priorities are to carry out the mandates of Congress, ensuring that technologies continue to contribute to growth in the economy, and that universal telephone service continues to be affordable.

At year's end

In a year when the summer's blockbuster movie *Jurassic Park* was a cinematic celebration of chaos theory, you can only wonder how the current telecommunications, computer and broadcast industry concepts of scalability, interoperability and convergence lend themselves to fractal analysis. At this point, the information superhighway looks like a light at the end of a big, new tunnel. With so many different vested interests on-board, however, that light could be the headlamp of a fast-approaching train. ■

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Circle (45) on Reply Card

New Products

frame will contain and power up to 12 combined DA/delay DA cards; differential inputs are provided to eliminate induced hum and interference.

Circle (366) on Reply Card

Portable stereo mixer

By Shure Brothers

• **FP32A:** offers three mic/line inputs and stereo capability; similar to FP32 mixer; offers more than 40 new features and improvements, including self-noise reduction by 30dB; 48V and 12V phantom, as well as 12V T (A-B) power are available to operate all types of condenser mics; active input gain controls simultaneously lower an input's volume level and increase its clipping point; front-panel switch activates peak limiters for the left and right outputs, which also can be linked to act as a stereo pair and are adjustable from 15dBm to 0dBm at output; features bi-color LEDs for each input indicating presence and peak levels.

Circle (367) on Reply Card

Sample rate converter

By NVision

• **NV1050:** 4-channel AES/EBU digital audio sample rate converter; can provide a cost-effective solution for frequency-agile sample rate conversion of off-speed AES/EBU digital audio data, including film-to-tape transfer, video standards conversion, 3/2 pull-down applications and field DAT recordings; accepts any AES/EBU input rate from 32-50kHz; supports varispeed sample rates; provides any AES/EBU output rate from 28-54kHz; accepts video/AES/EBU or word clock backtiming.

Circle (368) on Reply Card

Decoder/line doubler

By James Grunder & Associates

• **EDEC-2000:** by Yamashita Engineering Manufacturer; digital decoder and line doubler designed to enhance and improve NTSC video output; reduces noise, minimizes smearing and eliminates distracting artifacts, such as visual scan lines, cross-color, and dot and color crawl; uses 10-bit digital processing technology.

Circle (369) on Reply Card

DAW software

By Spectral Synthesis

• **StudioTracks 2.0:** adds support for removable media, plus greatly enhanced editing, mixing and patching features; all existing systems in the field are being upgraded at no charge to the owners.

Circle (370) on Reply Card

Amplifier

By Pro-Bel

• **Model 6255:** video and pulse distribution amplifier; features an integral cable equalizer, differential input and seven outputs; suited to applications that require variable delay or back porch clamp functions; 30MHz bandwidth and excellent slew rate characteristics ensure compatibility with HDTV and high-resolution graphics signals.

Circle (371) on Reply Card

Preview

JANUARY...

Remote Production Special Report

• Lightning Safety for ENG Crews

A look at the important elements that can protect remote broadcast crews from lightning injury or death. Learn what equipment and technology is available to predict when dangerous conditions are beginning to develop.

• Building ENG Microwave Links

BE will explore an ENG system that uses helicopters, base and mobile units that are capable of communicating with each other and relaying video and audio.

• Remote Power Systems

A look at the problems of getting clean power in the field along with some of the solutions that are available.

• Smart Battery Chargers

Don't let time run out on your batteries. Learn how smart chargers can extend the life of your batteries.

• Winter Olympic Games

A behind-the-scenes look at how the 1993 Winter Olympic Games were produced.

FEBRUARY...

Desktop Systems

• Desktop Platforms

The Amiga, Apple, IBM and Silicon Graphics are four different platforms available for desktop production. Find out the relative technical strengths of these systems and how popular they are in the production community.

• Buying a Desktop Video System

The key is to first define the tasks needed to be accomplished. Only then can the most cost-effective and efficient hardware/software be selected. The reader will walk through the criteria-defining process with the goal of a "best fit" to the client's needs.

• Squeezing the Picture: Video Compression

One key to modern video production systems is compression. A basic definition of video compression and how it applies to desktop video will explain the types available and the trade-offs that must be made when any signal is compressed.

• Ergonomic Considerations for Desktop

If you want to get the most from your desktop video system, just sitting it on your office desk won't work. Treat yourself to a thorough discussion of the importance of selecting the proper furniture for video production equipment.

• Applications of Desktop Technology: A Survey

What desktop platforms are used in the broadcast environment and what applications are they being used for? Find out the details in this survey.

News continued from page 4

ISI has targeted Nov. 15, 1994, for roll out in Portland when 20,000 TV households will have interactive television.

SCTE announces emerging technologies seminar

The society of Cable Television Engineers (SCTE) will begin 1994 with a conference on emerging technologies. It will be held Jan. 4-6 at the Pointe Hilton Resort in Phoenix.

The conference was orignially known as SCTE's annual fiber-optic show, but the scope of this year's event has been expanded to incorporate other technological advances affecting the industry. The conference will feature presentations on fiber-optic technology and digital compression and other technologies of interest to cable engineers, system managers, manufacturers and consultants involved in broadband communications.

Attendees will receive a manual containing information supplied by each presenter. Three optional pre-conference tuturials are being offered at an additional cost on Jan. 4.

For information, contact SCTE at 669 Exton Commons, Exton, PA 19341; phone 215-363-6888; fax 215-363-5898. ■

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2. Mail subscriptions	35,819	35,887
C. Total Paid and/or Requested Circulation	35,819	35,887
D. Free Distribution (including samples) by mail, carrier delivery or other means	2,473	2,472
E. Total Distribution (Sum of C and D)	38,292	38,359
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I certify that the statements made by me above are correct. (Signature of editor, publisher, business manager, or owner.)

Virginia Picotte,
Circulation Manager

Industry Briefs

BUSINESS SCENE

Sony Broadcast International, Basingstoke, England, has received more than 1,500 orders worldwide for its Digital Betacam VTRs. Some of the Digital Betacam VTRs have already been installed with major broadcasters, such as NRK, Norway; RTE, Dublin, Ireland; DirecTV, North America; and STAR-TV, Hong Kong.

TV2/Danmark, a Danish broadcaster, also has purchased a DVW-500P Digital Betacam recorder. In addition, Norwegian broadcaster NRK has chosen the HDIH-1200M high-definition video projector to be used during coverage of the Winter Olympics that will take place in Lillehammer, Norway.

The Trump Plaza Hotel and Casino, Atlantic City, has decided to revamp its video surveillance operation with Sony cameras and monitors.

Otari, Foster City, CA, has sold and installed 10 Concept I consoles since their release in June, with four more on order.

Odetics, Anaheim, CA, has delivered a TCS90 cart machine to WXXA-TV, Albany, NY. Also, KEKT-TV, Tyler, TX, has purchased on AccuCart cart machine with PVW decks.

Ampex, Redwood City, CA, has installed two DCT 700d tape drives at Turner Broadcasting Systems' Graphics Factory in Atlanta.

Panasonic Broadcast & Television Systems Company, Secaucus, NJ, has sold 22 AJ-D350 D-3 composite digital VTRs to Univision Network (Miami), the dominant Spanish-language TV company in the United States.

BTS, Simi Valley, CA, has provided a central routing switcher, control system and eight D-1 digital component tape machines to the Filmworkers Club, Chicago.

In addition, WCPX-TV, Orlando, FL, has purchased an LDK-491SR camcorder and 15 Betacam SP VTRs. The Radio and TV Commission of the Southern Baptist Convention has selected three LDK-9HS CCD studio cameras as well.

BTS also has provided two central routing switchers, two digital mixer/keyers and 25 Betacam SP recorders to Unitel Video, New York. WSBK-TV, Boston, has chosen four LDK 9P SR portable studio/EFP CCD video cameras for use on-board its 45-foot mobile production unit.

Avid Technology, Tewksbury, MA, has announced that its Film Composer digital non-linear system was used to edit the film version of Stephen King's novel "Needful Things."

Abekas, Redwood City, CA, has announced new package prices on its A82 composite digital switcher. The new system packages represent approximately 30% savings for those looking to go all-digital in composite production suites.

AKG, Vienna, Austria, has been acquired by Harman International Industries. Harman has acquired 76% interest from GiroCredit.

ITC Corporation, Bloomington, IL, has prepared a facility to brief radio station executives and technical professionals on the new digital technology being introduced into broadcasting. The program consists of a one-day seminar conducted at ITC's plant in Bloomington, IL. These seminars will cover digital audio programming advances in broadcasting, how they can be incorporated and integrated into existing systems, what advantages can be expected for personnel, audio quality, station operations and profitability.

The service is provided free of charge with hotel and food made available to qualified station managers and engineers. No purchase is necessary.

SOFTIMAGE and **Adobe Systems** have announced a joint sales and marketing venture for SOFTIMAGE Painterly Effects, a stand-alone, high-end library of special effects filters that provide the look of traditional artistic tools. The software program complements the Adobe Photoshop 2.5's image editing software. SOFTIMAGE Painterly Effects will be distributed at a special price for Adobe Photoshop program users through Adobe-authorized Silicon Graphics resellers.

Dielectric Communications, Voorhees, NJ, has announced the award of the first high-power HDTV-ready antenna from Maryland Public Television's WCPB-TV, Channel 28, Salisbury, MD.

The antenna selected was model TUP broadband UHF panel. The TUP panel antenna will allow WCPB to operate on its current Channel 28 now, and on any future UHF HDTV channel without tuning of antenna or transmission line.

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VINTEN MICROSWIFT SYSTEM self-contained used MH55 Vinten Robotic Head and lens model FUJA8.5X5. 5 BRM-28C set up for Sony BVP 7. System value new 40K, used system 15K or best offer. Will sell head alone as backup. (617) 245-6618. Priced to sell.

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HELP WANTED

BROADCAST ENGINEER Six-station network has an immediate opening for an experienced transmitter engineer at our Annapolis, MD site. Requires two years TV broadcast maintenance engineering experience (one year of which must include RF experience) and FCC General Class License or SBE Broadcast Engineer certification. Travel to other in-state transmitter sites will be required. Send resume and cover letter including salary history by January 21, 1994 to: Human Resources Department, Maryland Public Television, 11767 Owings Mills Blvd., Owings Mills, MD 21117. MPT IS AN AA/EOE EMPLOYER.

ENGINEERING: Radio and/or TV Strong Equipment and Transmitter Maintenance. CE position possible. Contact Gen. Mgr. WENY Inc., P.O. Box 208, Elmira, NY 14902. EOE/MF. (607) 739-0344/739-3636.

OKLAHOMA STATE UNIVERSITY Educational Television Services has re-opened a position for Director of Engineering. The general responsibilities include: developing and maintaining an operational system which effectively coordinates the scheduling of all technical facilities necessary to support the transmission, distribution, production and non-broadcast activities of the Telecommunications Center; developing long-range planning material for assigned areas consistent with the overall plan of the Telecommunications Center; maintaining state-of-the-art knowledge of technical requirements, equipment and systems required to ensure the Center's efficient and economic operation; ensure that the Center meets and maintains compliance with all local, state and federal rules and regulations; managing budgets for both operation, salaries, and capital, within prescribed guidelines; screening, evaluating, supervision, and training of assigned personnel. This position also will function as the engineering liaison for field operations for the U.S. Army TRADOC (TNET) project, providing technical assistance to both campus and contract personnel as required. Travel may be required. Minimum qualifications are a Bachelor of Science degree in Electrical Engineering or related field and at least five years of progressive and related technical experience, two of which in an administrative capacity. Seven years experience in C-Band and Ku-band satellite systems maintenance and operation is also required. Five years progressive experience in a university setting are preferred. Equivalent combinations of education and experience may substitute for above stated qualifications. To receive full consideration, submit resume and three references no later than Jan. 10, 1994 to: Director of Engineering Search, Educational Television Services, Oklahoma State University, Stillwater, OK 74078-0585. Screening begins immediately. EOE.

BROADCAST RECORDING TECHNICIANS. National Public Radio currently has openings in the Audio Engineering Division for Broadcast/Recording Technicians. Candidates must have live on-air production multi-machine mixing and intensive remote experience. NPR technicians must work shifts throughout the broadcast week (24 hours, seven days) and travel as needed. Experience with all analog broadcast and high quality recording equipment is essential. Familiarity with digital editing, multi-track recording is desirable. Applicants must be dependable. To apply send cover letter and resume to: National Public Radio, Personnel Department - #684, 2025 M Street NW, Washington, DC 20036. NPR is an Equal Opportunity Employer.

ELECTRONICS ENGINEER. National Public Radio has openings in the Engineering Services Unit of the Audio Engineering Division for Electronics Engineers. You will be responsible for designing, constructing, installing, testing, maintaining and repairing NPR's technical equipment. Candidates must have demonstrated ability to trouble-shoot to the component level; at least 3 years broadcast and/or recording studio equipment maintenance experience and working knowledge of drawing, word processing and spreadsheet applications. The position will require shift work. To apply send cover letter and resume to: National Public Radio, Personnel Dept. #52, 2025 M Street, NW, Washington, DC 20036. NPR is an Equal Opportunity Employer.

MOBILE UNIT ENGINEER. Fast growing mobile television company is seeking an experienced maintenance engineer to perform all aspects of remote engineering on broadcast television mobile units. Must be capable of component level fault diagnosis, have knowledge of triax based cameras, Grass Valley production switchers, as well as audio systems and video tape machines including Beta and one inch. Electronics education required, traveling a must. Send resumes to: Maynard Video Productions, 27555 Ave. Scott, Valencia, CA 91355.

WANTED: ENGINEER. An expanding mobile video production company is looking for an E.I.C. (Engineer In Charge) with 5 or more years of mobile and engineering experience. Commercial driver's license preferred. Send resume, salary requirements and a list of references to: Metro Mobile, Attn: Vern Tigges, 4701 J St. SW, Cedar Rapids, IA 52404. (319) 363-2002.

RF MAINTENANCE TECHNICIAN. Advanced technical school education or completion of engineering courses specializing in electronics and RF Technical Systems is desired. Demonstrated knowledge of FCC rules and regulations pertaining to RF and microwave transmission, as well as an FCC radio telephone license is required. Must possess demonstrated technical knowledge of all mobile, portable and fixed RF audio and video equipment ranging in frequency from 170 MHz to 23 MGHz. Amateur or 2 way experience a plus. Extensive travel to remote television origination sites is required. Qualified interested applicants should forward resumes to: Human Resources Dept., ESPN, Inc., ESPN Plaza, Bristol, CT 06010. ESPN is an Affirmative Action/Equal Opportunity Employer.

JOB ANNOUNCEMENT. Corporation engaged in sales and service of video and communication, graphics, and production management systems seeks a National Sales Manager to: 1) Direct and coordinate sales activities of Broadcast/Video and High Density Imaging Division of Company. Responsible for sales and market development throughout North America of Barco-brand product lines of video monitors, high resolution and presentation monitors, cable and satellite products, and professional audio equipment. Markets include professional TV, satellite and cable markets, professional audio markets, and professional color measurement markets. Product Models include: Barco CVS, CVM 2000 and AVM series monitors, VSBM 1000 modulators, and VSD 1000 demodulators; 2) Develop advertising campaigns to stimulate consumer demand for products described above and achieve sales goals. Monitor information of competition's products within industry and make technical recommendations to improve our product's design, respond to competition, and enhance market share; 3) Prepare and analyze customer sales results, marketing reports, sales forecasts, and market trends; 4) Inform customers of latest technical developments in above-described product lines to maximize customer satisfaction; 5) Coordinate liaison with engineering and manufacturing personnel regarding technical modifications to improve or eliminate unprofitable products, to respond to customer preferences for broadcast products, and to maintain competitiveness within broadcast/video and HD Imaging industry; and 6) Travel an average of three (3) weeks per month maintaining relations with customer base, and participating in major industry shows. Experience/Education: Seven years of experience in business or electronics may count as two years of experience. Work Schedule: 40+ hours per week/8:30-5:30/M-F. Base Salary: $70,000-$80-000 per year. Apply in Person or by Resume to: Georgia Department of Labor, 2972 Ask-Kay Drive, Smyrna, GA 30082, Job Order No. GA 5670459, or to the nearest Georgia Job Service Center.

TV MAINTENANCE ENGINEER: Needed in Gulf Coast Vacation Market. Must be a highly motivated and versatile individual who is a team player. Must have 3-5 years experience repairing 3/4", M-2 1" tape equipment and other ENG and studio equipment. FCC General Class License required. Send resume to A. Dallas, WJHG-TV, P.O. Box 2349, Panama City, Florida 32402. EOE.

ELECTRONICS FIELD/SHOP ENGINEER. Swiderski Electronics, Inc. located in the Chicagoland area, is looking for an Electronics Field/Shop Service Engineer with a min. of 2 years exp. Individual to work with Broadcast/Industrial $^1/_2$", $^3/_4$" & 1" VTR's and related equipment. Full time position. Full company benefits. Send resume & salary history to: Human Resources Dept., 1200 Greenleaf Ave., Elk Grove Village, IL 60007. Fax resume to: (708) 364-5019.

LEITCH

Leitch is seeking an experienced sales representative in the Midwest (Chicago area). The successful candidate will have many years experience in television broadcast equipment sales. Respond in writing to:

John Walter, President
Leitch Incorporated
920 Corporate Lane
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Fax: 804-548-0247

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WANTED: USED VIDEO EQUIPMENT. Systems or components. PRO VIDEO & FILM EQUIPMENT GROUP: the largest USED equipment dealer in the U.S.A. (214) 869-0011.

KNCT-TV needs spare parts for RCA TTU 30B/C transmitter, Contact Ed Loftis 1-800-792-3348 ext. 1307.

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Contact Renée Hambleton, at (913)967-1732, for information on frequency and pre-payment discounts. To place your classified ad send your order and materials to Broadcast Engineering, Classified Ad Mgr., P.O. Box 12901, Overland Park, KS 66212-2215.

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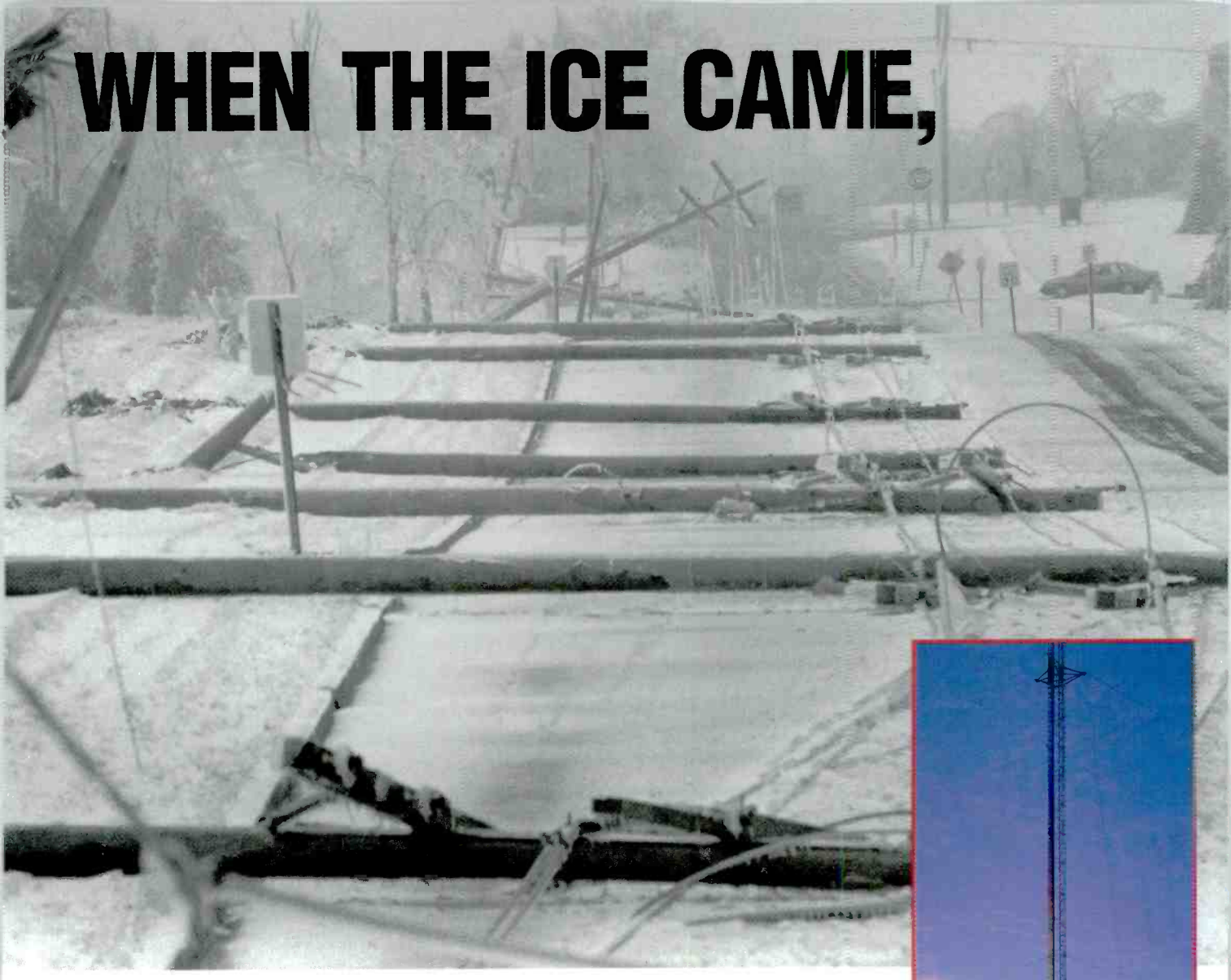

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