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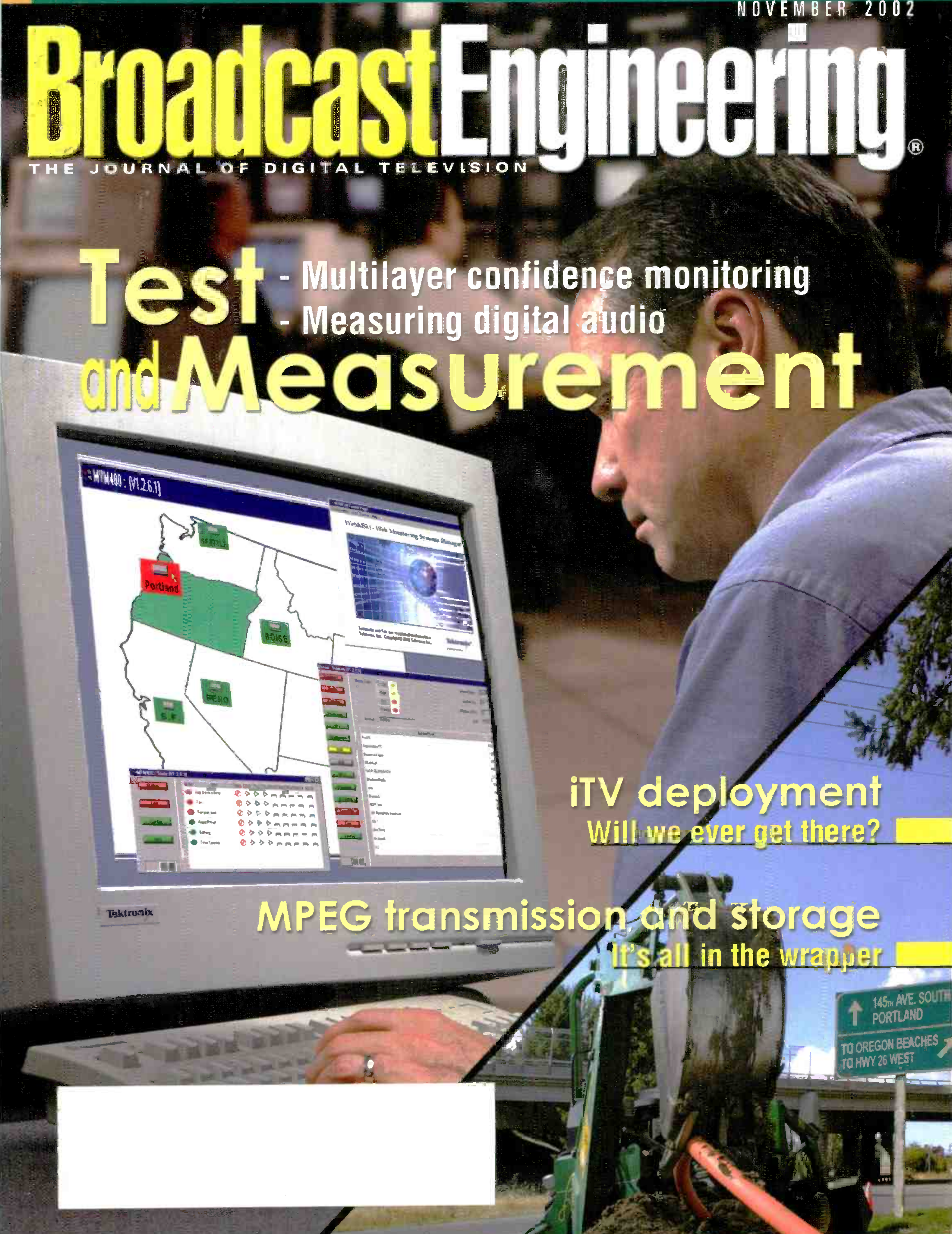

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ON THE COVER: With today's digital monitoring technology, an operator can pinpoint a network problem from almost anywhere. Pictured: Tektronix MTM400 MPEG transport stream monitor. Photo by Jason Kinch.

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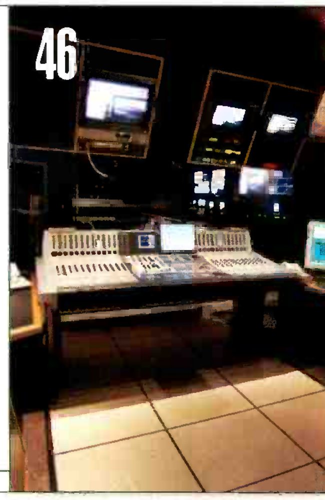

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Traveling light

Name the brand and model number of this handheld ENG/field camera. It weighed 16 pounds including lens and viewfinder. Weight of the backpack was not specified. Title your entry "Freezeframe-November" in the subject field and send it to bdick@primediabusiness.com. Correct answers received by Jan. 17, 2003, are eligible to win.

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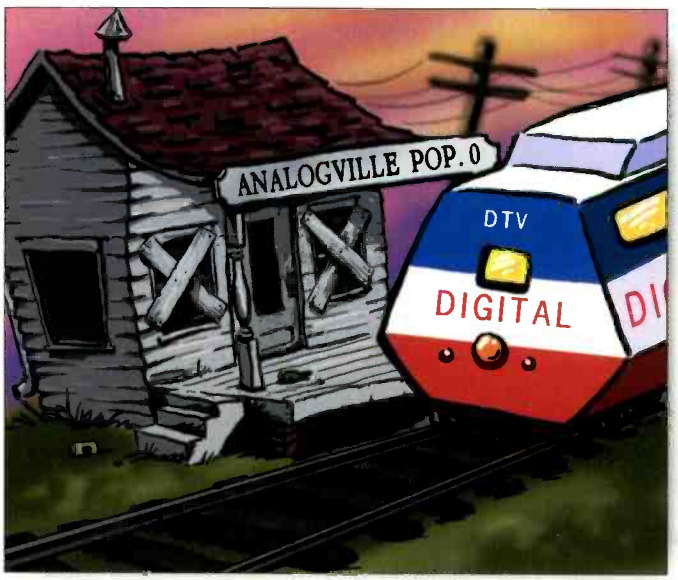
The train's leaving

I don't like taking *Broadcast Engineering* readers to task for their positions and comments, but it's time to remind a few of you that ignoring and even arguing against the digital transition won't win you any friends, and could negatively impact your future.

Way back in September 1997, I wrote my first "get on the DTV train" editorial. It took no great wisdom to predict that the television industry was going to go digital and that everyone had better adopt the technology soon. Well, we've come a long way in those five years. That DTV train has left the station and is now merely a dot on the horizon. Are you on board?



Most readers understand that technology continually moves forward and that DTV not only will happen, but is already well on its way to full reality. From consumers to cable, everyone is embracing digital for all it's worth and wanting even more. No, analog isn't dead. You may still be able to buy LPs, but there sure isn't much demand for them, is there? The same goes for analog TV.

Unfortunately, a few continue to ignore reality. I received a letter last week from a reader spouting that HDTV was a solution looking for an application. He is wrong. Consider these facts.

HDNet just announced their HD coverage of the SKUSA Super Nationals via DirecTV. ESPN announced that it's adding an HD network next April. The network, ESPN-HD, will be a high-definition simulcast of ESPN. The network is planning 100 live telecasts of selected major league games. ABC has announced it will broadcast the Super Bowl, the Stanley Cup finals and "Monday Night Football" in HD beginning in 2003. All this means that the top networks are providing significant HD material. (Too bad FOX can't figure it out.)

And, viewers are buying HD sets. DTV product sales are up 81 percent from last year. Spend an hour in your local electronics outlet. Watch consumer after consumer buying HDTV sets. Sure, many buy the HDTV sets because they're cool and DVDs look really good on them. But, you can bet that when they discover that HD is available over the air or from cable, they'll want it in their home.

But consumers aren't the only indication that digital is here to stay. I often use system integrators as sounding boards. Companies like The Systems Group, Doyle Technologies, Professional Communications Systems, AZCAR and others are staffed with some of the smartest people around. When I wonder where technology is going, I ask these folks.

I have to tell you — these companies aren't building any big analog facilities.

Now, if you still think that DTV and HD are technologies looking for an application, you might want to consider a career change.

Brad Dick

editorial director

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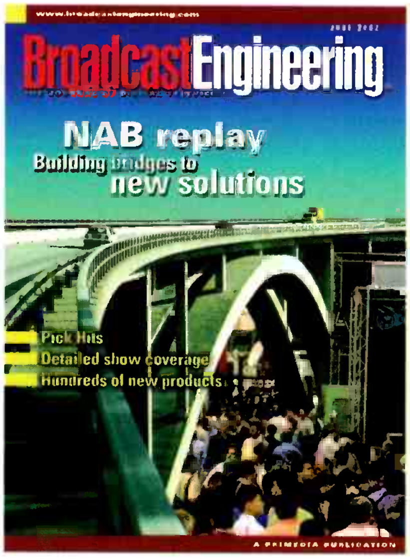


Overcranking HD

I run a post company in South Africa, and we too have experimented with overcranking HD, as discussed in the Production Clips column of your June issue. If you combine this technique with some of the software slo-mo tools, you can get good results up to 120 fps with very few artifacts, even on the transfer back to film. Long live HD and independent films.

GRAHAM COOKE
G-VISION DIGITAL POST

No need for DTV

To the editor:

DTV/HDTV is a solution in search of a problem! The supposed "free" channel only requires the television broadcaster to spend millions on an unproven technology to continue serving its viewers, and in return for spending those millions on this equipment presently being developed, they will be required to give up their present profitable station. Even after six years, there is no profitable digital television broadcast business model. Where's the equity? Where's the need?

I'm of the opinion that DTV/HDTV for terrestrial service is a boondoggle serving only the financial interests of the equipment suppliers (who have had no new "toy" to sell in quite some time); the production houses (with the same story); and the FCC (anxious to auction off spectrum for bucks).

When it requires a set larger than 32 inches to be able to tell the difference between analog and digital, it appears a lot less money could have been spent improving analog, with the resultant product equal in stature.

This will ultimately be settled by the consumer who, frankly, I think is making his or her voice heard already. Since the inception of off-air DTV, just under 300,000 sets have been sold (through Dec. 31, 2001), and there were only 29 million color analog sets sold in the United States last year!

There may be a niche market for DTV. But I doubt seriously that I will live to see the last analog station turned off in the United States. Can you imagine the political howl that will be raised – just by the 29 million consumers who bought sets last year – if, as you suggest, immediate obsolescence is forced upon them? Get real!

GERALD R. PROCTOR

There were . . . 29 million color analog sets sold in the United States last year!

Freezeframe winners

March Freezeframe:

Name this famous broadcast landmark, photographed in 1967, and what important industry event took place in the city that year.

The photo shows the twin towers of Marina City, home of WBKB (Channel 7) and WFLD (Channel 32), in Chicago. The important industry event held in the city that year was the 1967 NAB convention.

Winners:
Jim Borgioli
Don Rhodes
Harvey Caplan
Henry Ruhwiedel
Murray Bevitz, MBA

April Freezeframe:

What camera company made the "Polychrome" color camera? What feature made it unique?

Several readers answered correctly that Sarkes Tarzian made the "Polychrome" color camera. Fewer correctly guessed that the feature that made it unique was that it offered users a choice of pickup tubes. Users could choose Plumbicon or Vidicon tubes.

Winners:
Murray Bevitz, MBA
Charlie Sears
Floyd H. Miltz
Gary W. Blievernicht, Michigan State University
Wilson Louis Brown

May Freezeframe:

Name this famous broadcast transmission site. The photo was taken in 1967.

The site was Mt. Wilson outside of Los Angeles.

Winners:
Sally Rich, Dielectric Communications
Stuart Jagoda
Todd R. Loney, Electron Dynamics
Karl Sargent, California Oregon Broadcasting
Stan Amster
Philip S. Angerhofer, ABC
Matt Brown

BE

Little "i," BIG "TV"

BY CRAIG BIRKMAIER

Whatever happened to iTV?

Better yet, what is it? The big "TV" part is easy to grasp, but what does the little "i" designate?

At the height of the dot.com craze, that little "i" became a fashionable way to indicate that a product was linked in some way to the Internet. Long before the Internet wave crashed upon the landscape of our emerging digital world, however, the little "i" was used to designate what many felt would become the next big thing for the big "TV"... interactive! Then the Internet crashed the iTV party.

Interactive TV is not a new idea. You might even say it has touched the life of this author since childhood and throughout his professional career. The first truly interactive television program, "Winky Dink and You," aired from 1953 to 1957. The interactive element of the children's show was created through the use of special plastic sheets that a child could attach to the television screen and draw on with crayons. Yup, this was my first experience with "color" TV.

iTV surfaced again in Columbus, OH, in 1977. Warner Communications' Qube, offered thirty channels of television divided equally between broadcast, pay-per-view and original interactive channels. Although Qube's innovative programming was quite popular, it was not a sustainable business model because of the high costs of its set-top boxes and other equipment.

By the early '90s, as the transition to digital television moved to the center of my journalistic radar screen, iTV surfaced once again. The cable industry was gearing up to turn the big "TV" into a big business opportunity. In 1994, I attended the gala premiere of the Time Warner Full-Service Network (FSN) prototype in Orlando, FL. FSN was the world's most sophisticated and expensive interactive television test bed, offering interactive shopping, games, sports, news and an electronic program guide, as well as movies on demand.

The FSN concept proved to be too much too soon, but it did provide Time Warner with valuable research, which has led to the development and recent deployment in multiple markets of a new video-on-demand (VOD) service dubbed iControl.

The timing of the FSN experiment was ill-fated at a fundamental level. A videotape given to the press at the gala premiere set the stage:

"The benefits that the full-service networks will be offering to cable subscribers are essentially three elements: choice, control and convenience. You're going to have greater choice of what you want to watch. You're going to have much more convenience in that you'll be able to watch it when you want to watch it. And it will give you greater control because you'll have more options, more things to do, such as shopping or play games, that will allow you more time to do other things that you'd like to do."

The benefits that the full-service networks will be offering to cable subscribers are essentially three elements: choice, control and convenience.

But what was Time Warner really saying? We are going to control your choices and collect a toll for everything that takes place on our networks.

What really happened with respect to these critical elements of the business plan?

Regarding choice, DBS burst onto the scene, offering the advantages of being digital and offering more choice than cable. And the Internet's World Wide Web rapidly evolved into a powerful standards-based platform for interactive communications.

Regarding control, the ability to manage and control your digital media experiences is moving to the edges

FRAME GRAB A look at the issues driving today's technology

Bringing the theater home

Consumers flock to the Home Theater in a Box

Year	Unit sales	Sales (in $ millions)	Average price
1998	784,000	$224	$286
1999	806,000	$229	$284
2000	1,157,000	$331	$286
2001	2,250,000	$765	$340

SOURCE: Adams Media Research *www.adamsmediaresearch.com*

of the network, the point of consumption, not a big server in a bomb-proof shelter under a mountain. The personal video recorder has emerged as the appliance that will enable you to watch what you want, when you want to watch it, although the big cable MSOs still believe that VOD services in thousands of headends can compete effectively with the PVR.

Regarding convenience, the question is for whom: the cable MSO or the consumer?

Consider the following from the videotape: "This world-class team of engineers, designers and programmers is charged with writing the FSN's operating software; the computer code that will enable all the different components of the system to talk to each other. Every person or company who wants to create an application for the Full-Service Network will use this common language. And developers will follow a style guide created by the FSN team."

How convenient. The ongoing desire of cable MSOs to control the customer and collect tolls for every transaction on their networks ran headlong into the wild world of the Web. Content producers faced the prospect of creating different versions of their applications for every proprietary system vs. the global reach and open standards of the Web.

Faced with the challenge from the DBS "Death Stars," cable was forced to invest in a $50 billion upgrade of their distribution networks to support digital services. One of the most positive aspects of these system upgrades is the ability to offer broadband Internet connections alongside digital TV programming, including two "low-overhead" interactive applications – the Electronic Program Guide (EPG) and VOD.

Cable systems – especially those here in the United States – have largely ignored the opportunity to use their digital transition to launch new iTV services such as

Sky Digital, the DBS service for Great Britain, has been offering interactive enhancements for a wide range of programming for several years. This image illustrates some of the interactive enhancements for sports programming.

those envisioned by Time Warner in 1994. There are two contributing factors.

First, the cost implications for the set-top boxes (STBs) needed to access digital services. The boxes used in the 1994 FSN experiment were Silicon Graphics workstations that cost about $5,000 each. Moore's law has trimmed the cost to support iTV applications to about $100, but that's $100 more than the cable systems are willing to invest today.

One major reason for the reluctance to invest in more capable STBs is the second factor. Cable MSOs are charging on average about $40 per month for a broadband Internet connection, and the customer usually pays for the cable modem.

So for now, instead of iTV, cable systems are offering the Internet and digital TV.

> iTV is alive outside of the United States, but it would not be honest to say that it is thriving.

Where are the deployments?

iTV is alive outside of the United States, but it would not be honest to say that it is thriving. The problem is all too familiar. The business today is still dominated by proprietary solutions, even as standards have emerged from Europe's Digital Video Broadcast group (MHP), and the ATSC (DASE) and Open Cable (OCAP) here in the United States.

Several years ago the prospects for iTV looked promising. Several U.S. broadcasters tested the waters using what has become known as the two-screen approach to iTV; a traditional TV for the video program and the Internet for the interactive application.

The two-screen interface was an outgrowth of a phenomenon discovered by accident. Several TV networks noticed that when they displayed a Web URL during a live broadcast it would cause a huge, almost instantaneous spike in Web surfers accessing the Web site. How could this be? These people were watching TV, right?

Not exactly. A little research revealed that up to 40 percent of the TV audience was surfing the Web while watching TV.

But the two-screen approach is far from optimal. Real iTV enthusiasts are longing for the day when it will be possible to deliver the program and the interactivity to the big "TV" screen.

During the era of irrational exuberance in high tech, before the dot.com meltdown, significant investments were being made in iTV. As is often the case with emerging technologies, the major players opted for the development of proprietary solutions in the hopes of gaining control of the emerging markets.

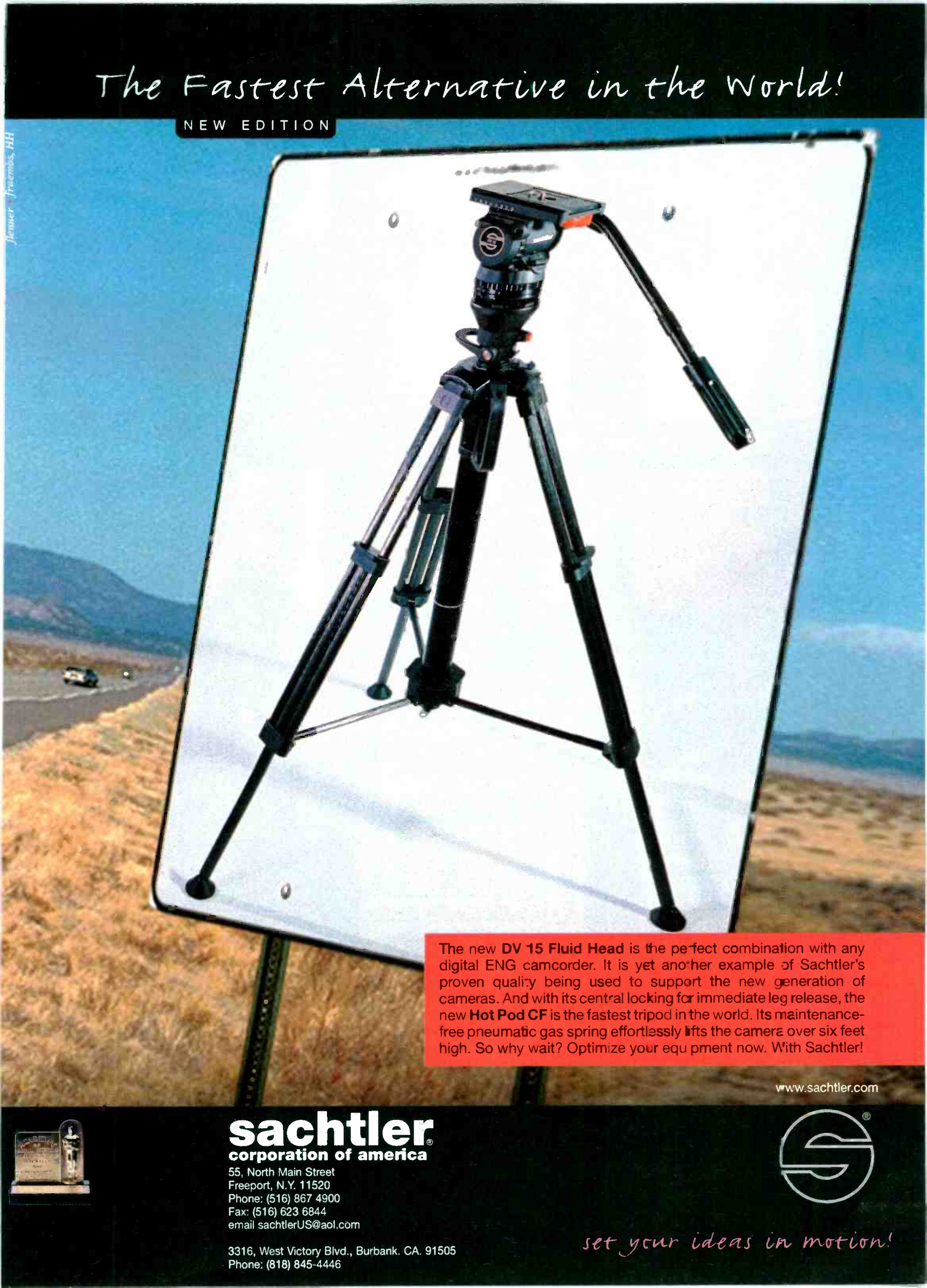
As the new millennium dawned, I was touched once again by iTV, participating in a series of conferences that brought together the community working to deliver iTV to the masses. The first iMIX Conference in April of 2000 was upbeat; participants were optimistic about the future. By the time the third iMIX conference took place in March of 2001, the mood had turned sour. The question on the tip of every participant's tongue was "Where are the deployments?"

The answer was a deafening silence. When the high tech bubble burst, iTV was placed on the back burner. Challenges to the dominance of the lean back big "TV" business model had been dealt with. The big "TV" content producers and distributors boldly proclaimed that they had given iTV a close look. They noted the high cost to enhance TV programming with interactivity and questioned why anyone would want to interact with most programs.

Meanwhile, the Internet has been characterized as a major threat to the future of Hollywood, the music industry and broadcasting. It is portrayed as a haven for pirates who will share perfect copies of digital media content. It is a threat that MUST be controlled. BE

Craig Birkmaier is a technology consultant at Pcube Labs, and hosts and moderates the OpenDTV Forum.

SEND Send questions and comments to: cbirkmaier@primediabusiness.com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CASE STUDY

KWCH-TV Wichita, Kansas

Company Name:
KWCH-TV

Headquarters:
Wichita, Kansas

Number of Stations:
KBSD-TV, Dodge City
KBSH-TV, Hays
KBSI, Goodland
Local Cable Channel

Critical Needs:
Multi-channel operation
CentralCasting configuration
Total automation
Flexibility of control to support live broadcasts

Don Vest, Chief Engineer

Five years ago, Don Vest, Chief Engineer at KWCH-TV in Wichita, Kansas knew facility improvements had to be made. The station needed a flexible automation solution that combined the power of disk-based media storage systems with the reliability of tape-based technologies. As a result, the station chose Odetics Broadcast to help transform its broadcast operations from its single channel, mostly manual master control to a fully modernized, multi-channel automated broadcast facility. "We chose Odetics because they demonstrated a better understanding of how a television station is programmed and operates," says Vest. With Odetics' AIRO™ Automation System, KWCH has been able to extend its capabilities from controlling one station to three others in the Western Kansas area.

Since 1996, KWCH has taken advantage of the scalability and adaptability offered by the AIRO system to meet the station's increasing channel requirements without adding complexity or additional staff. The latest upgrade included integrating the addition of a new AIRO system with their existing AIRO system. "Odetics delivered the capability to merge the media database in the two systems so it would operate as one – this has made a big difference in our capabilities," adds Vest. "This gave us an eleven channel system – eight channels in the new system using MPEG-2, and three channels in the previous system using JPEG."

With AIRO, KWCH is also able to control four stations from one central location and with one operator, all running a different playlist. "This has had a great impact on decreasing the switching errors and improving the technical quality of the commercial spots. Thanks to AIRO, discrepancies reported by the Western Kansas stations have decreased from two pages a day to maybe a single entry" explains Vest.

The AIRO system also gives Vest the flexibility he likes. "We can break away from the combined control, bring in extra operators and run each individual station as a standalone, or even combinations of stand-alone and combined control. And we can do all this while at the same time running a totally separate channel on cable that is virtually unattended."

Where is Vest looking now? "Expansion, expansion, expansion. I'm ready to work with Odetics to continue to expand the AIRO to program our DTV channel."

get on AIRO™

Politics and DTV

BY HARRY C. MARTIN

After coming down hard on the electronic manufacturing industry for foot-dragging on DTV, the FCC, in this election year, has declined to take action on a number of controversial and long-pending DTV issues. It had been anticipated that the Commission would, during its September meeting, address at least some of those issues, which include multichannel must-carry, satellite carriage, cable tier digital programming and the quality of the digital signal as carried by a cable system.

The Commission's reluctance to act is rooted in politics. There is wide disagreement among Chairman Powell and his three fellow commissioners about how the Commission should proceed on digital must-carry.

When the commissioners will look at these issues is anyone's guess. Most likely, they may wait until well after the November elections, when the composition of the new Congress and its telecom subcommittees becomes clear.

In the meantime, Representatives Billy Tauzin (R-La.) and John Dingell (D-Mich.) circulated a draft bill that would require broadcasters to begin digital-only broadcasting by Dec. 31, 2006, regardless of the number of digital sets in service in any community. At the present time, broadcasters are subject to a Dec. 31, 2006, deadline for final transition from analog to DTV – but that deadline is subject to an exception which provides that there be at least 85 percent digital use in any market before stations in that market would be required to convert to digital. Under the proposed legislation, that 85 percent litmus test would be removed and Dec. 31, 2006, would be an absolute drop-dead date not subject to any exemptions.

Tauzin has been an outspoken critic of the broadcast industry for failing to move more quickly to implement DTV and make more DTV programming available. To many, though, the Tauzin-Dingell approach is another example of the government trying to force a consumer-driven industry to move forward when there is clearly little or no consumer demand, particularly in a very weak economy.

The FCC has declined to take action on a number of controversial and long-pending DTV issues, and it's anyone's guess as to when the commissioners will look at them.

Regulatory fee delinquencies mean big problems

A little-known consequence of making late regulatory fee payments is worth highlighting.

The hefty 25 percent late payment penalty that the FCC assesses on regulatory fee payors is a strong incentive to get those payments in on time. In addition, however, prospective participants in FCC auctions are required to certify under penalty of perjury that they are not currently delinquent on any non-tax debt owed to any federal agency. If you are currently in default, you cannot participate at all in the auction. If you are a "former defaulter" who has since cured your outstanding delinquencies, you may participate but you have to pay 150 percent of the upfront payments that would otherwise be due.

One auction participant recently became all too familiar with these provisions when it received a notice that a regulatory fee from last year had apparently been received by the FCC one day late. The licensee wanted to dispute the 25 percent late fee, which was assessed by the FCC on the eve of the auction. The late fee involved was only a few hundred dollars, but the applicant had to pay the disputed fee in order to be eligible to participate in the auction. Then, adding insult to injury, it had to make an additional 50 percent upfront payment because it had taken on the status of a "formerly delinquent" payor. In some auctions, this add-on to the upfront payment could amount to thousands or even millions of dollars, even though the late payment at issue was only a hundred dollars. BE

Dateline

The next FCC deadline for television broadcasters is Jan. 10, 2003, when quarterly problems/programs lists must be placed in stations' public files and Forms 398 (children's program reports) must be filed with the FCC.

The deadline for NCE-TV stations to complete their DTV buildouts is May 1, 2003.

All stations must file biennial ownership reports in 2003 on the anniversary of their renewal application filing dates.

The television renewal application cycle will begin again in 2004.

Harry C. Martin is an attorney with Fletcher, Heald & Hildreth PLC, Arlington, VA.

Send questions and comments to: harry_martin@primediabusiness.com

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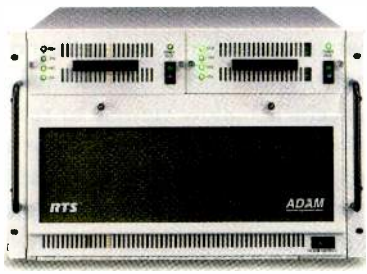

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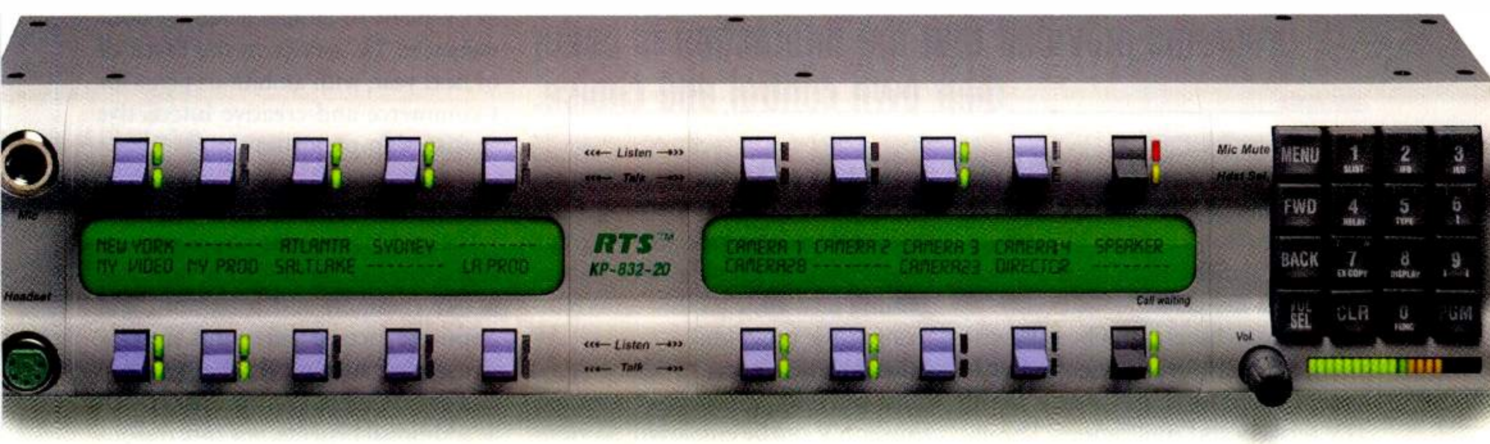

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Making money with DTV

BY KENNETH HELPS

The United States has about 70 million homes receiving cable TV and about 15 million homes receiving satellite TV. Over the next 10 years the entire world will switch to digital TV broadcasting. The drivers for switching to DTV are: consumers, politics, and television broadcasters gaining from cost savings on bandwidth, greater business opportunities and potential for greater revenue streams.

Digital interactive TV is now entering a new phase in its development. Much of the experience thus far has suggested that the initial walled garden services are not being used as much as expected. There is still inertia about shopping and banking through the TV – as the TV remains primarily an entertainment medium. This has increasingly led broadcasters into trying to understand where the revenue is going to come from, and indeed, how we are going to make money with DTV.

Certain programming such as "Big Brother" and Wimbledon sports broadcasts have started to change the levels of interactive usage, bringing in large audiences. Various applications like interactive ads, Web TV, and interactive games, sports and weather are also in demand.

There have been a number of comprehensive studies of viewers' attitudes in regards to the wide array of iTV services and applications. The industry is starting to build a composite picture of the types of services that are generating revenue, and a profile of the type of viewers adopting these services. Studies have found that viewers will interact with programs provided that the interaction is under their own control and choice. Informational enhancements allow viewers to receive information on demand about the program. Viewers also like to use the interactive enhancement to "play" along with the program and provide answers to poll questions or vote.

Studies have found that viewers will interact with programs provided that the interaction is under their own control and choice.

Enhanced TV as a revenue generator

Enhanced TV allows viewers to activate via remote control on-screen information that is displayed alongside the program. It also displays such items as program-related information and advertising messages.

Broadcasters' first steps into enhanced TV have enabled us to see how different channels and different categories of programs are utilizing this new functionality. There are those looking to enhanced TV to increase program and channel revenues. Many are looking to engage the viewer directly, to find out something from them that feeds back into the program; others want to provide some sort of gaming and added-value entertainment to the program.

Game shows appear to be one of the most obvious examples of how enhanced TV can be employed. As viewers, how often do we think we know the correct answer, or believe we would have triumphed where others failed? Gambling, game play and voting will be some of the key models of enhanced TV.

It's been no real surprise that kids are early adopters of new technologies. In fact, Nickelodeon has been using enhanced TV to try and ascertain what type of programming kids want to view. Viewers were allowed to vote on a choice of programs every half hour to determine what was shown next on the channel.

Kids were given different methods of voting for their favorite program. In addition to voting via interactive TV, they could vote by telephone or online at the Nickelodeon Web site. Their aim was to increase viewer retention through interactive content and ultimately lead to increased revenue. Nickelodeon found that during the week more than 290,000 votes were cast via the remote control, while 180,000 were cast via the telephone and 60,000 via the Internet.

Music has been another area with experimentation in iTV. MTV has tried several ideas, from generating revenue via phone lines to posting updates and hosting competitions. MTV plans to launch a full 24-hour enhanced TV service in the first half of next year, with ambitious plans for t-commerce and creative interactive sponsorship opportunities.

What will drive revenue?

The reasons for adopting digital TV center around the desire for more and better channels and programs, and improved picture and sound. Interactive services such as Web access, e-mail and home shopping are primarily seen as additional benefits, not core reasons for adoption. This is not to say that


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interactive TV won't play a more prominent role in the future.

With enhanced TV, the industry is starting to build a more composite picture of the key reasons for wanting to interact. One study reports that the main drivers for using interactive features include increased involvement in programming, a need for information and updates, and the need to improve enjoyment of linear programming.

These factors are endorsed by the findings of a report from Van Dussledorp & Partners. Audience patterns reveal that participation and direct involvement are important motivations behind iTV service consumption. Having the opportunity to vote and express personal qualities through quizzes and text messages are emerging as the key themes of interactive TV. In order to attract new users and lead to a gradual change in user television behavior, iTV applications should be simple, relevant and avoid complex content and interfaces. Successful iTV applications that will deliver revenue have to offer highly entertaining content with broad market appeal through intuitive interfaces.

The reasons for adopting digital TV center around the desire for more and better channels and programs, and improved picture and sound.

Digital TV can offer the consumer better quality pictures, sound, interactivity and a greater choice of television channels. The technology gives the broadcaster more bandwidth, thereby offering opportunities to broadcast new PPV channels targeted at specific audiences, such as MTV and the Medical Channel. Adding iTV capability further allows targeted advertising to specific population demographics and regions.

Broadcasters need to start working together with technology companies to harness and understand what is possible with this new digital TV platform. Because DTV is a combination of computer and broadcast technology, the possibilities for new ideas appear to be endless. To be successful, broadcasters are going to have to rethink their current broadcast model. However, thinking outside the box will result in greater options and more revenue than ever before. **BE**

Kenneth Helps is the corporate director of Cabot Communications, www.cabot.co.uk.

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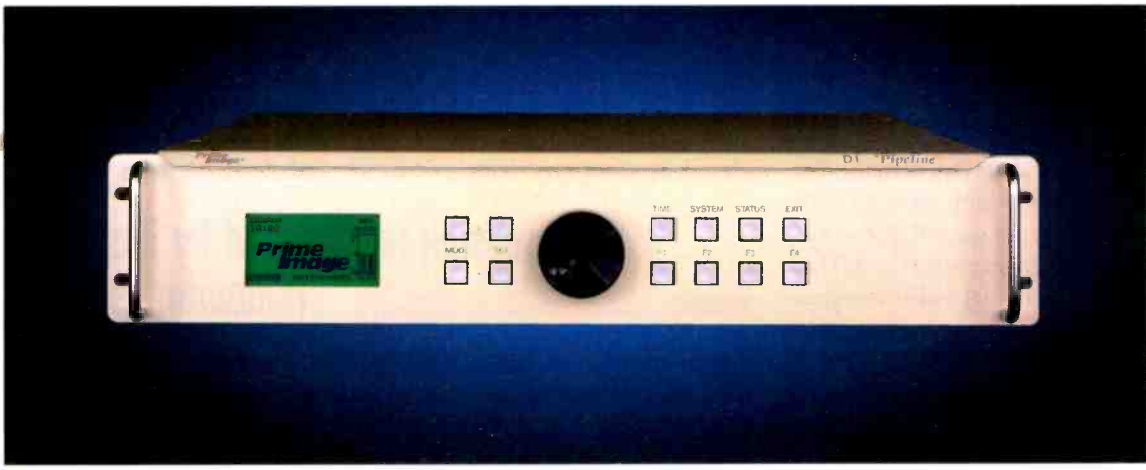

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Video compression

BY MICHAEL ROBIN

A visual information source requires a transmission or storage medium to convey its message to the observer. The fidelity of transmission and reproduction of the message is closely related to and dependent on the available medium capacity and the manner in which it is used. In the digital world the medium capacity is expressed in bits per second. Sometimes it is erroneously expressed in MHz.

The goal of digital video compression is to represent an image with as low a bit rate as possible, while preserving an appropriate level of picture quality for a given application. Compression is achieved by identifying and removing redundancies.

The MPEG-2 techniques

The MPEG-2 compression system uses a combination of lossless and lossy techniques to reduce the bit rate. Taken separately, none of these techniques can provide significant data reduction. However, by using the right combination of several techniques, very efficient data reduction systems can be designed.

The lossless techniques are:

- Blanking removal: The horizontal and vertical blanking areas are not recorded or transmitted. They are replaced by short sync data specific to

Compression is achieved by identifying and removing redundancies.

the application. A Rec. 601, 10 bits per sample, 4:2:2 bit-serial datastream has a bit rate of 270Mb/s. Removing the nonessential blanking data results in a reduced bit rate of 207Mb/s without affecting the picture quality
- Discrete cosine transform (DCT): A mathematical process that converts spatial amplitude data into spatial frequency data. The image is divided into blocks of eight horizontal pixels by eight vertical pixels (lines) of luminance (Y) and corresponding color difference (C_B and C_R) samples. A block of 8x8 pixels is transformed into a block of 8x8 coefficients describing the signal amplitude at a particular frequency. Essentially, the signal is converted into one value for the DC component and 63 values for 63 frequencies. This process is equivalent to a spectrum analysis. The coefficients are read out sequentially in a zigzag fashion, block after block. The process is totally transparent.
- Variable-length coding (VLC): Also called Huffman coding and entropy coding. This technique assigns fewer bits to code frequently occurring coefficient values and more bits to others.
- Run-length coding (RLC): This technique relies on the repetition of the same data sample value to generate special codes that indicate the start and end of a repeated value.

There are two lossy compression techniques:

- Sample subsampling: An effective data reduction method resulting in a loss of picture resolution. It is applied to chrominance signals resulting in the 4:2:0 and 4:1:1 formats. A 4:2:2 bit-serial signal, with a reduced bit rate of 207Mb/s, can be subsampled by reducing the number of bits per sample to eight and adopting a 4:2:0 structure. The result is a 124Mb/s bit rate.
- Requantizing: This process assigns more bits to low frequency coefficient values and fewer bits to high frequency coefficient values.

The MPEG-2 data structure

The MPEG-2 data structure is made

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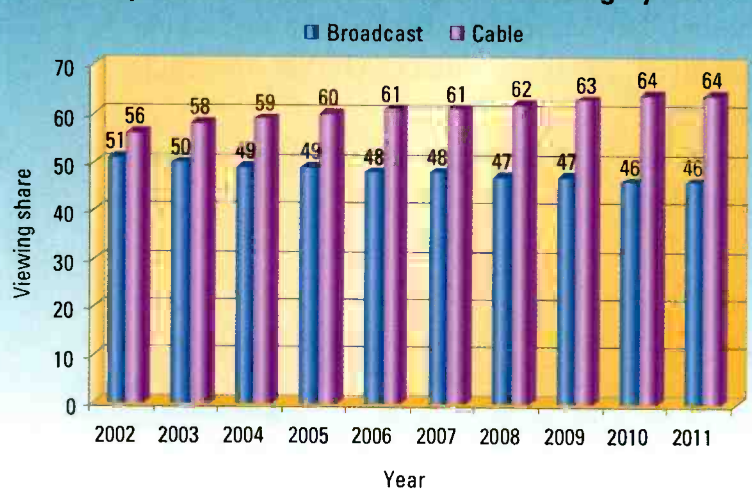
TV viewing shifts

Cable may control almost two-thirds of viewing by 2011



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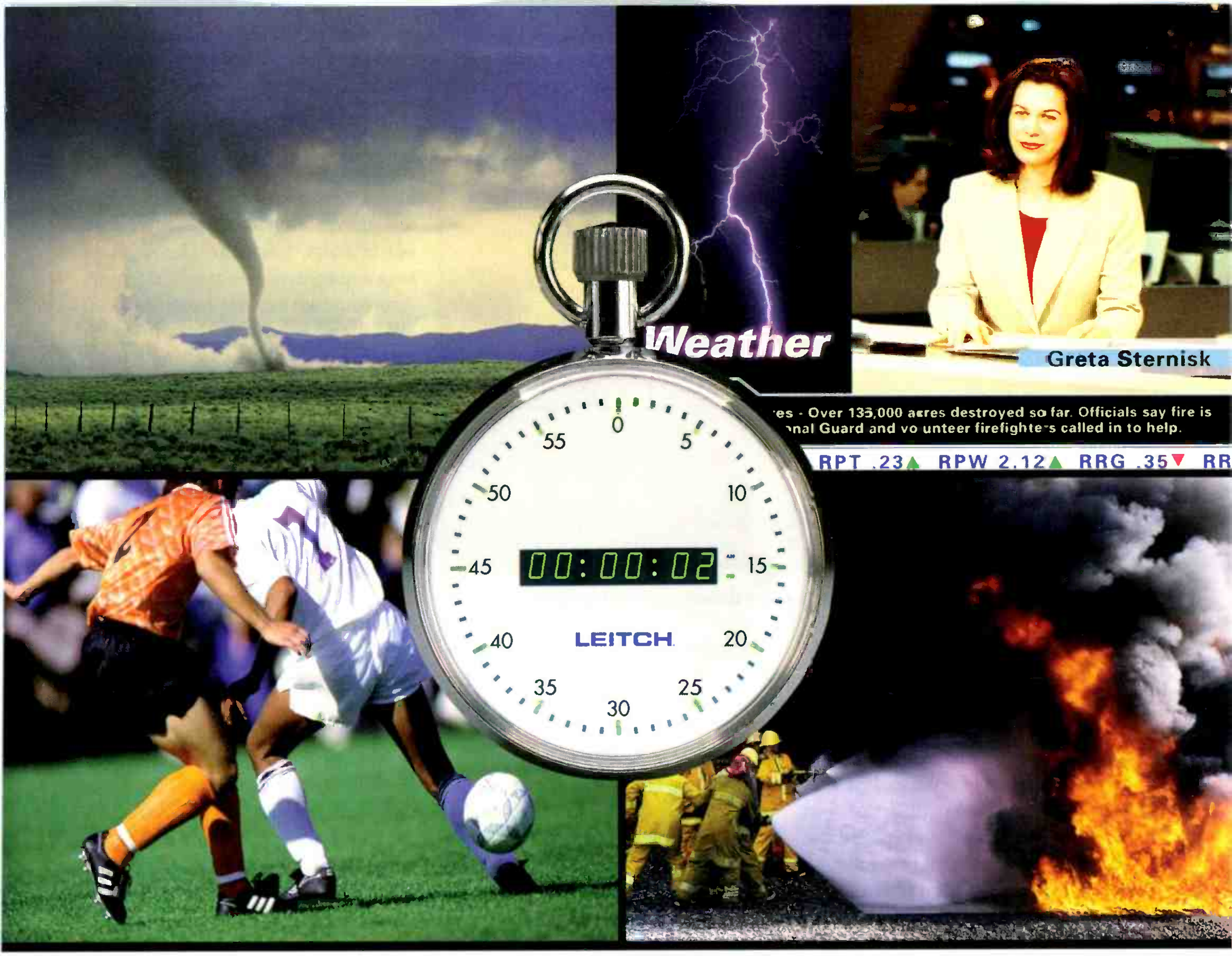

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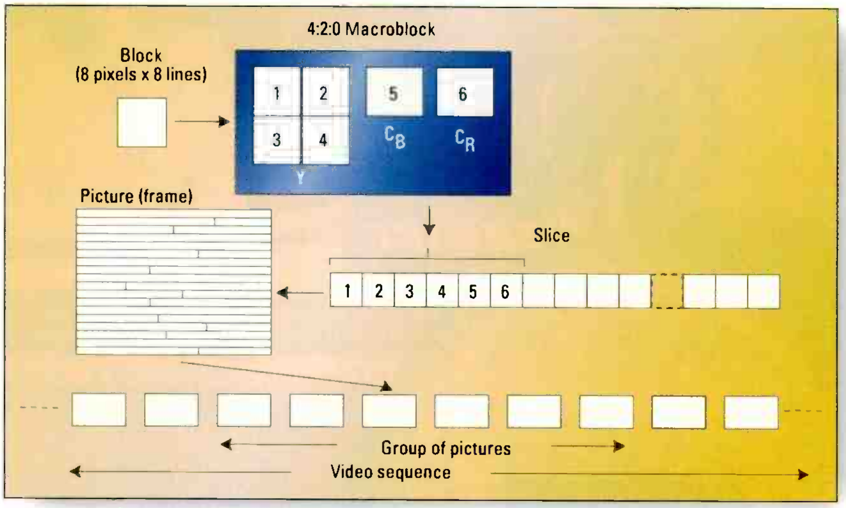


Figure 1. Six layers make up the MPEG video datastream architecture.

up of six hierarchical layers. These layers are the block, macroblock, slice, picture, group of pictures (GOP) and the video sequence. Luminance and chrominance data are separated in 8x8 blocks of Y, C_B and C_R values. In a 4:2:0 format, macroblocks consist of four blocks of 8x8 Y values (16x16 pixels) and one block each of C_B and C_R values. A slice is made up of a number of contiguous macroblocks. The order of macroblocks within a slice is the same as the conventional television scan: from left to right and from top to bottom. Header values indicate the position of the macroblock within the picture and the quantizing scaling factor.

The picture is the primary coding unit in a video sequence. It consists of a group of slices that constitute the actual picture area. It also contains information needed by the decoder such as the type of coding (I, P or B) and the transmission order.

The GOP is made up of a sequence of various combinations of I, P and B pictures. It starts with an I picture which provides the reference for following P and B pictures and identifies the point for switching and tape editing. GOPs typically contain 15 pictures, after which a new I picture starts a sequence of P and B pictures.

The video sequence includes a sequence header, one or more GOPs, and an end-of-sequence code. The header contains information about the picture. The video sequence is known as the video elementary stream. Figure 1 shows the makeup of a 4:2:0 video sequence.

Intraframe compression

Intraframe (I) or static compression uses a combination of lossy and lossless schemes applied to the information present in the picture itself. As most television systems employ interlaced scanning, there is a temporal difference between the two consecutive fields. MPEG-2 allows pictures to be either a field or a frame, so there can be intrafield coding producing two pictures per frame. I pictures provide only moderate amounts of compression. Figure 2 shows a conceptual block diagram of a compression scheme producing I pictures. The full bit rate SDI 270Mb/s signal (4:2:2, 10 bits per sample) is first reduced to an eight-bit-per-sample, 4:2:0 representation before feeding the compressor. The input signal enters a spatial coder consisting of a DCT processor followed by a requantizer (REQ). The requantized DCT coefficients are read out in a zigzag fashion. The resulting long sequences of low amplitude, near-zero values are variable-length encoded (VLC) and subsequently run-length encoded (RLC). They are multiplexed with quantizing information and feed a buffer. The buffer controls the REQ to prevent the occurrence of overflow or underflow, and the result is a constant bit rate and variable picture quality.

Interframe compression and motion compensation

In a moving video picture most of the changes that take place from field to field are produced by an object moving from place to place or uncovering objects and picture area. When a picture area shows no motion, the best predictor for a pixel or block of pixels is the same group of pixels in the previous field or frame. In this case the prediction error will be zero or close to zero. VLC could be applied to reduce the bit rate. If there is motion in a picture area, simple prediction from the previous fields or frames will be incorrect and large prediction error values will increase the bit rate. This problem is solved by using motion compensation. This consists of a search within a confined region of the previous field or frame for the pixel or pixels that come closest to the current input signal. The digital information transmitted or stored consists of coded prediction error values plus the displacement vectors that locate the group of pixels in the previous field or frame. Motion compensation is used for a group of

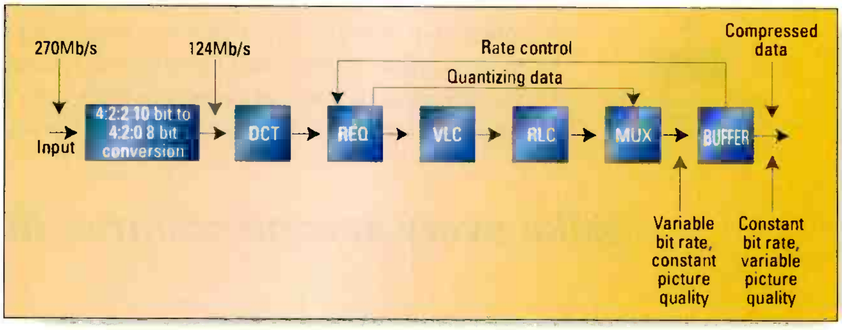
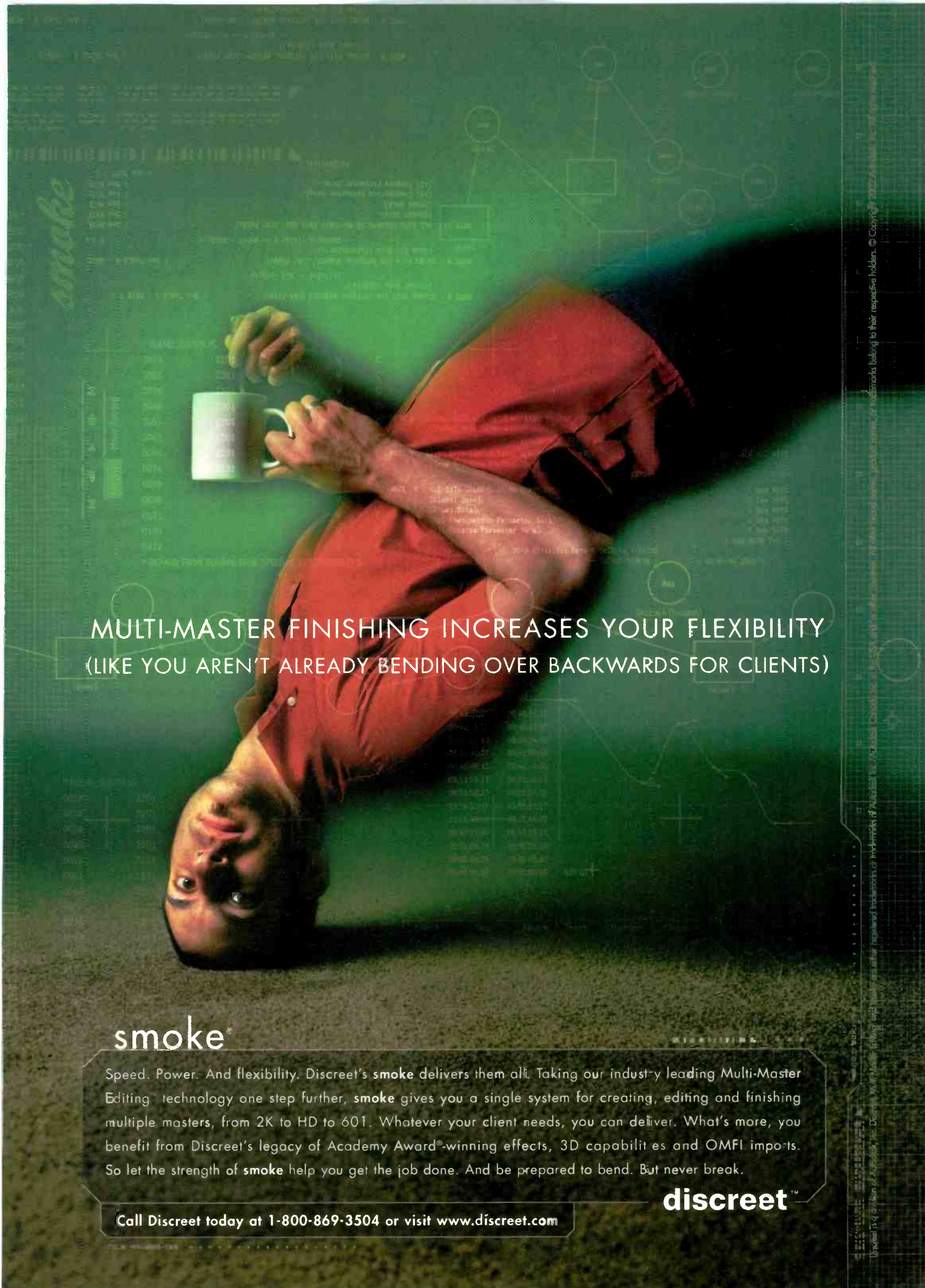


Figure 2. An intraframe compression scheme uses lossy and lossless techniques to produce I pictures with only moderate compression.



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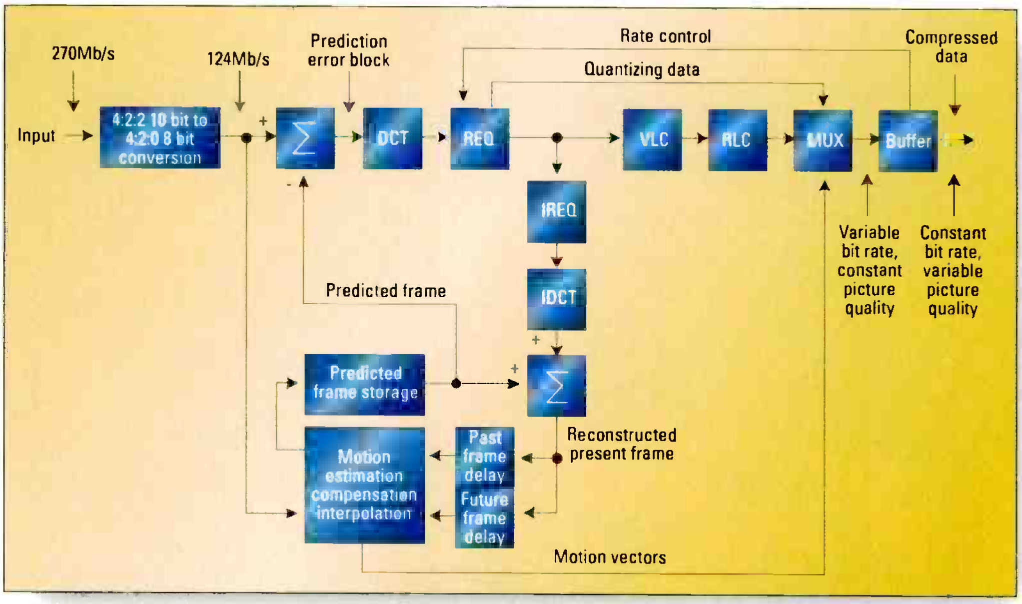

Figure 3. This interframe compressor generates forward-predicted P frames or bi-directionally predicted B frames.

pixels, commonly a luminance (Y) macroblock consisting of four 8x8 pixel blocks. In most cases it is accurate to assume that all Y pixels, as well as the associated C_B and C_R pixels in a given macroblock, will experience the same displacements from one picture to the next.

Figure 3 shows a conceptual block diagram of an interframe compressor. It is a combination of intraframe and interframe encoders and can generate forward-predicted P frames or bi-directionally predicted B frames.

The predicted (P) pictures are coded with respect to the nearest previous I or P picture. The technique is called forward prediction. The output of the spatial coder feeds a spatial decoder that consists of an inverse REQ (IREQ) and an inverse DCT (IDCT). Its output simulates the output of a receiver decoder and feeds one of the inputs of an adder. The output of the adder feeds a future and a past frame delay. In the case of P frames, only the past frame delay is activated. The motion estimation block compares the present frame with the reconstituted past frame and feeds a predicted framestore. The output of the predicted framestore feeds the second input of the adder as well as the input subtracter. If the predicted P frame is identical to the present frame, the prediction error is zero and the bit rate is considerably reduced. If there is a prediction error, it is encoded by the spatial encoder and a motion vector is generated to indicate the correct position of the macroblock. Even if there is a prediction error, the bit rate is still lower than the original so there is a compression gain. However, coding errors can propagate between frames, since a P frame may be used as a reference to future P and B frames.

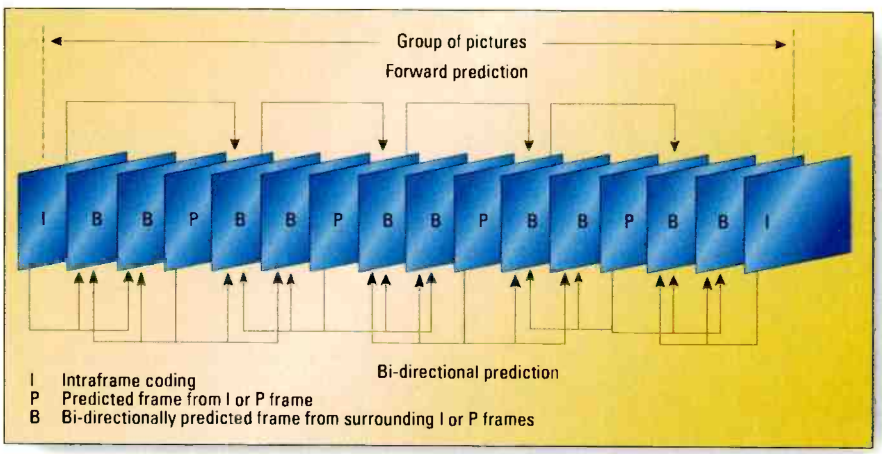

Figure 4. A sequence of frames comprise an MPEG group of pictures (GOP), one of the six hierarchical layers of the MPEG data structure.

The bi-directional (B) pictures use both future and past pictures as a reference. The technique is called bi-directional prediction. In this case both the past and the future frame delay are activated and their outputs are interpolated to generate the bi-directional predicted B frame. This process provides the most compression and does not propagate errors because a B frame does not serve as a reference.

The difference between an encoder capable only of P pictures and one capable of both P and B pictures lies in the available reference picture delays. Forward prediction requires the storage of only the past frame. Bi-directional prediction requires the storage of a past as well as a future frame.

Figure 4 shows a typical sequence of frames making up a group of pictures (GOP). A typical I, B, P MPEG-2 encoder can compress the Rec. 601 270Mb/s bit rate down to 8Mb/s without visible picture impairments. BE

Michael Robin, a fellow of the Society of Motion Picture and Television Engineers and a former engineer with the Canadian Broadcasting Corp.'s engineering headquarters, is an independent broadcast consultant located in Montreal, Canada. He is co-author of Digital Television Fundamentals, *published by McGraw-Hill.*

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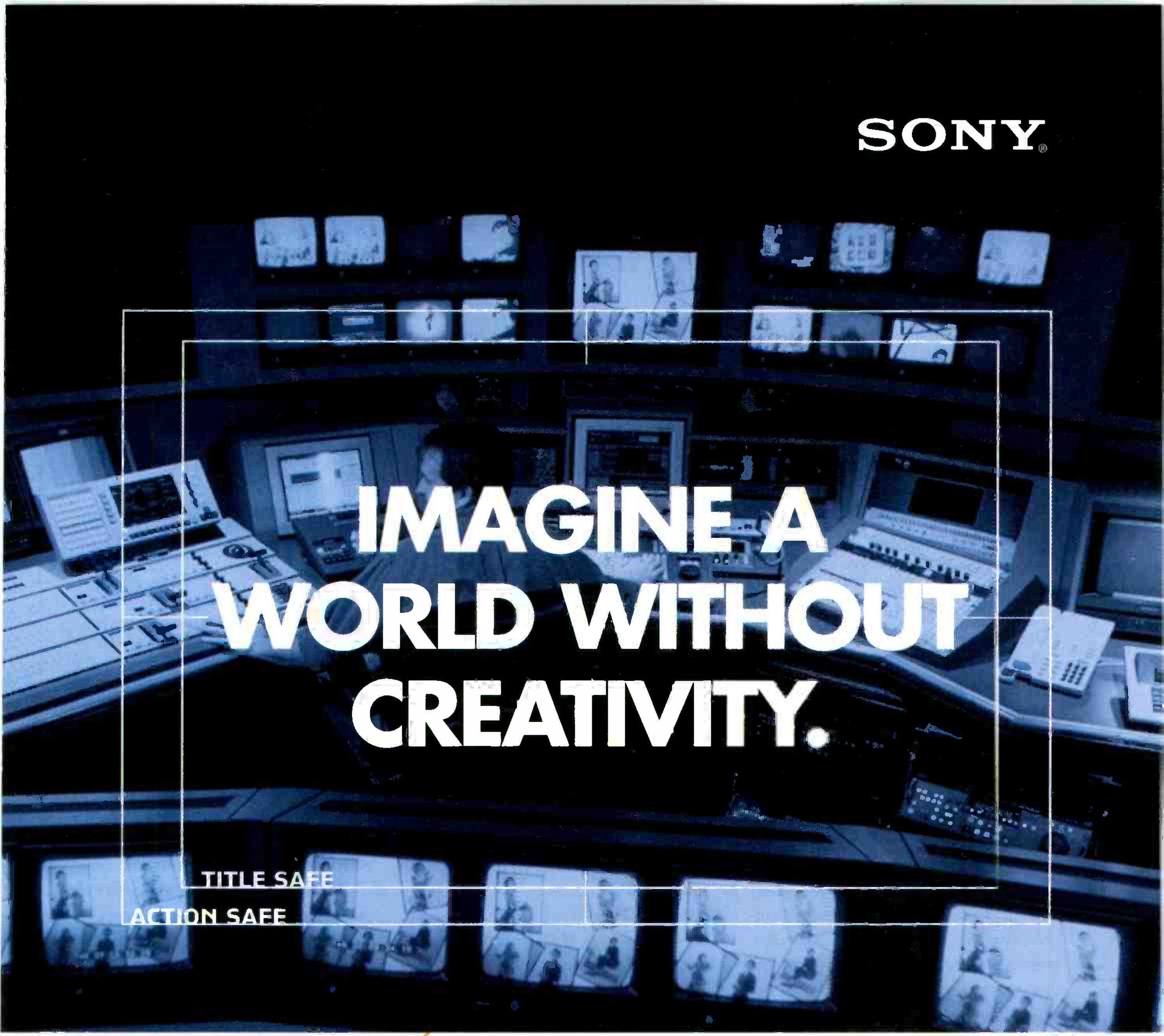

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ATM for broadcast

BY BRAD GILMER

Asynchronous-transfer mode (ATM) is a core telecommunications technology that evolved from analog voice service, X.25 and frame relay. ATM is the evolutionary technology that is best able to fulfill the quality-of-service (QoS) requirements for today's isochronous applications. It is likely that IP will eventually be able to make similar claims, but there are still issues to be resolved before streaming broadcast video can be easily carried across public IP networks.

Voice networks started as analog transmissions over copper wires using tube-type line amplifiers and mechanical crossbar switches. Such early voice networks had several problems. They were error-prone, expensive to lease and relatively unreliable for transmitting data between facilities. But, at the time, it was the best technology available. With the advent of solid-state electronics and integrated circuits, this service was converted to digital. The use of pulse-code modulation (PCM) permitted the multiplexing of many voice lines onto a single circuit.

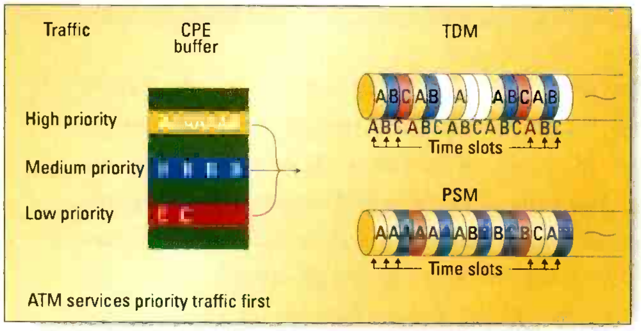

Figure 1. This comparison between TDM and PSM shows how ATM uses PSM to service high-priority traffic first. Image courtesy SBC-TRI.

X.25 networks were developed to address the shortcomings of analog networks. X.25 is a layer-3 protocol that guarantees data integrity through store and forward, error checking, and hop-by-hop acknowledgment. X.25 was the first network technology that allowed customers to pay only for the traffic they generate.

Frame-relay networks are based upon layer-2 protocols, and were originally designed to achieve speeds up to 45Mb/s. Frame-relay switches work in round-robin fashion, so they can't service traffic by priority and type. Frame relay also does not provide QoS parameters that establish service guarantees. Finally, frame relay creates switch overhead because frame boundaries are not predictable.

ATM allocates bandwidth fairly and prioritizes traffic based on the needs of the application.

Enter ATM

ATM, however, differs significantly from these predecessors. It allocates bandwidth fairly and prioritizes traffic based on the needs of the application. A full range of QoS parameters are available to create a Service Level Agreement (SLA) or contract for service across a connection. This is extremely important for any public network. Also, ATM has small fixed-length cells that switch faster with deterministic behavior. Some may argue that ATM's small cell size is inappropriate for video. They say small cells lead to inefficiency because the ratio of header information to payload is relatively high. This argument is correct in local network installations. But the flexibility and speed afforded by the smaller cell size across a nationwide public switched network greatly outweigh the cost of the header overhead.

As its name implies, ATM permits asynchronous networking. This contrasts with networks that use time-domain multiplexing (TDM). Figure 1 shows that TDM allocates a time slot to each piece of multiplexed traffic on a periodic (synchronous) basis, whereas the prioritized statistical multiplexing (PSM) used in ATM gives higher-priority traffic more time slots based on a well-defined algorithm.

ATM is connection-oriented, although it also provides connectionless protocols outside the network. When operated as a connection-oriented protocol, ATM requires a virtual connection (either a permanent virtual circuit or a switched virtual circuit) before the network can accept traffic. During the ATM setup time, switches allocate bandwidth to the virtual circuit for the duration of the "call." This is another key aspect of ATM for broadcast. An ATM virtual circuit configured with the proper QoS parameters has a guaranteed bandwidth available to handle the video connection.

ATM circuits can handle a mix of traffic types, including voice, data and video. The user requirements for each type are different. With voice traffic, the bandwidth requirement is low (less than 64kb/s) and users can talk at any time. But there is very little tolerance for delay during transmission. Studies have shown that delays over about 250 milliseconds severely impact the ability of people to talk naturally over a voice link.

Data transmissions over ATM can be

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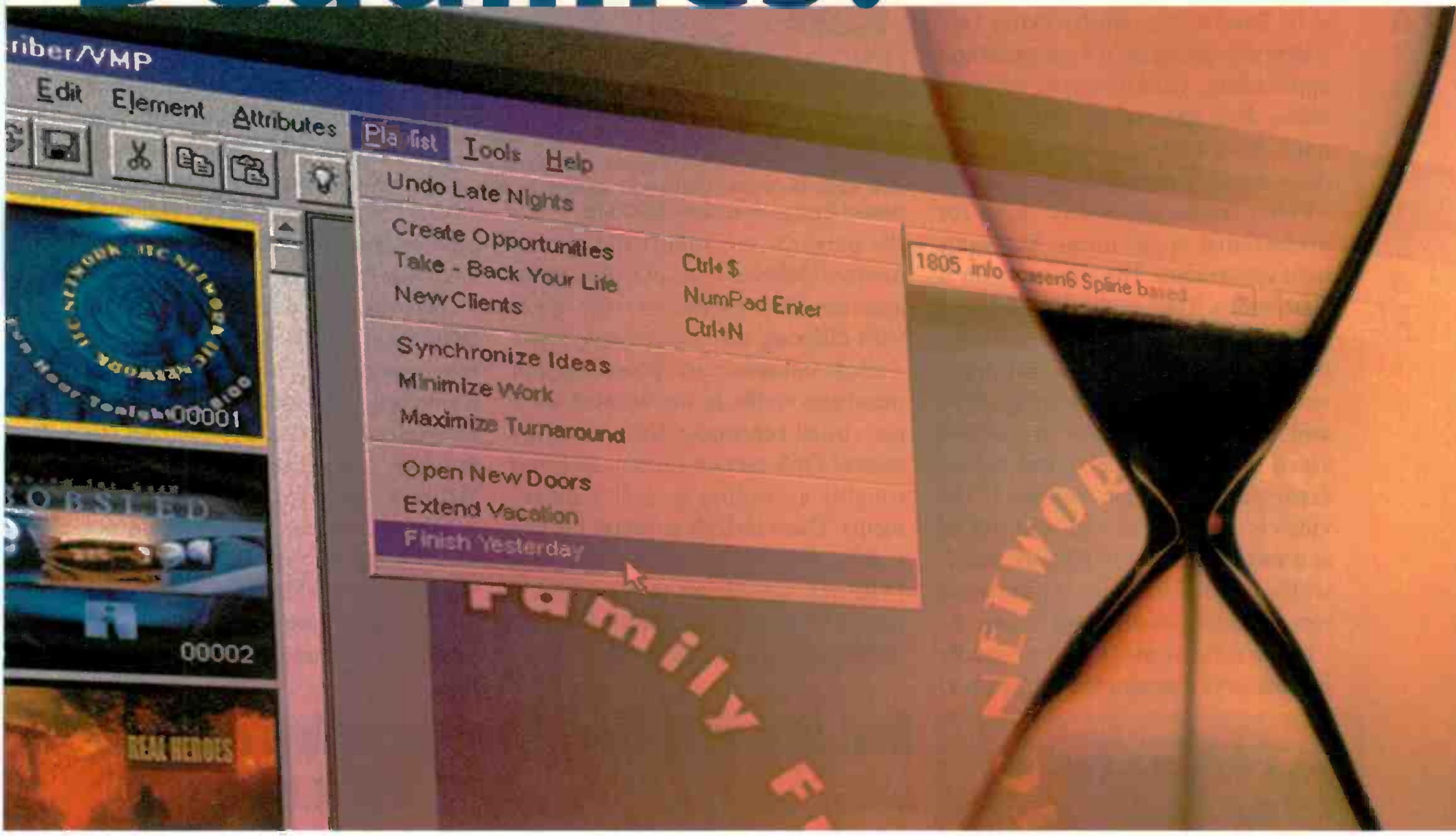

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based on connection or on file transfer. Unlike broadcast video, ATM buffers computer data and transmits it in bursts when bandwidth becomes available. Bandwidth requirements vary widely depending on the customer and application. Compared to voice or video, data applications generally are much more tolerant to delay, jitter and other network disturbances.

Video traffic, especially video for professional applications, has some tight constraints. The transmission is continuous. Thus, at the output of the network-edge device, data must appear in the proper order and meet video's requirements for delay, jitter and wander. Real-time interactive video requires low delay and tighter error control. Furthermore, if the video is compressed and transmitted at a variable bit rate (VBR), the bandwidth required for video transmission can be highly variable and bursty.

In the ATM world, QoS can specify various service parameters. QoS allows

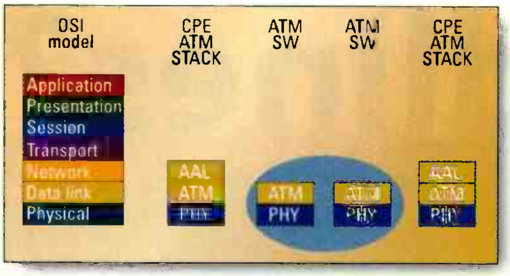


Figure 2. ATM is a layer-2 protocol that specifies the data link and physical layers in the OSI model. Image courtesy SBC-TRI.

the network to support the service needs of different types of traffic. It can accommodate multiple traffic types with differing user requirements over a single infrastructure. It services and prioritizes traffic in the network on a per-virtual-connection basis. There are several QoS service classes, grouped roughly according to user requirements. These include constant bit rate (CBR), variable bit rate – real time (VBR-rt), variable bit rate – non-real time (VBR-nrt), available bit rate (ABR) and unspecified bit rate (UBR).

the network interface of the remote application.

ATM cells have a 48-byte payload. To get the user data broken down into these payloads, the AAL contains a convergence sublayer (CS), which provides application-specific timing and control. The segmentation-and-reassembly (SAR) rules break down CS protocol data units into 48-byte cell payloads (see Figure 3).

There are several standardized ATM adaptation layers. AAL-1 is for real-time, constant bit rate applications. It is primarily used for circuit emulation. Each cell contains an AAL-1 header. For example, AAL-1 can be used to map SDI into ATM. AAL-2 is for real-time variable-bit-rate applications. It is not widely used because most developers have found AAL-5 better suited and less complicated to use. AAL-3 and AAL-4 (connection-oriented and connectionless, respectively) have been merged into AAL-3/4 and are primarily used in Europe. They have not been widely adopted elsewhere due to high payload overhead and packet-interleaving complexity. AAL-5 is used for most traffic types other than CBR. It has minimal control-field overhead, and it automatically pads cells to ensure 48 bytes per cell.

The ATM layer appends a four-byte header for address and control purposes. There are two types of ATM cell headers: user-to-network interfaces (UNI)

ATM service classes:

Constant bit rate (CBR)
- Professional, high-resolution, high-bandwidth video
- Intolerant of cell delay and cell loss

Variable bit rate – real time (VBR-rt)
- Video conferencing and lower-quality professional video
- Medium bandwidth, more tolerant of cell delay

Variable bit rate – non-real time (VBR-nrt)
- Videotape feeds
- Higher bandwidth, no cell-delay concern
- Some cell-loss toleration because of retransmit capabilities of end devices

Available bit rate/unspecified bit rate (ABR/UBR)
- Computer data, videophone feeds
- No cell-delay concern, some cell-loss toleration because of retransmit capabilities of end devices

Real-time interactive video requires low delay and tighter error control.

Layer-2

ATM is a layer-2 protocol. Figure 2 shows how ATM specifies the data link and physical layers in the OSI model. The ATM adaptation layer (AAL) maps traffic into the cell payload. The ATM layer adds control data in the cell header. The physical layer maps cells to transmission media, typically synchronous optical network (SONET) on switched public networks. The customer-premises equipment (CPE) takes the network output of a device and, using AAL, maps the data onto the ATM network. Once inside the network, the ATM switches establish connections and route cells using the information in the ATM cell headers. The information is then extracted from the ATM cells at the other end using ATM customer-premises equipment and presented to

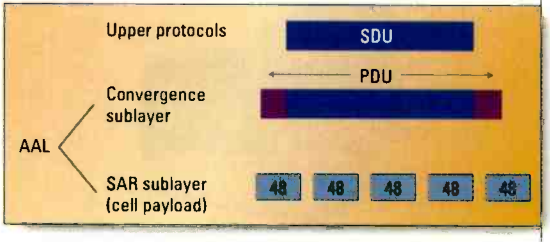
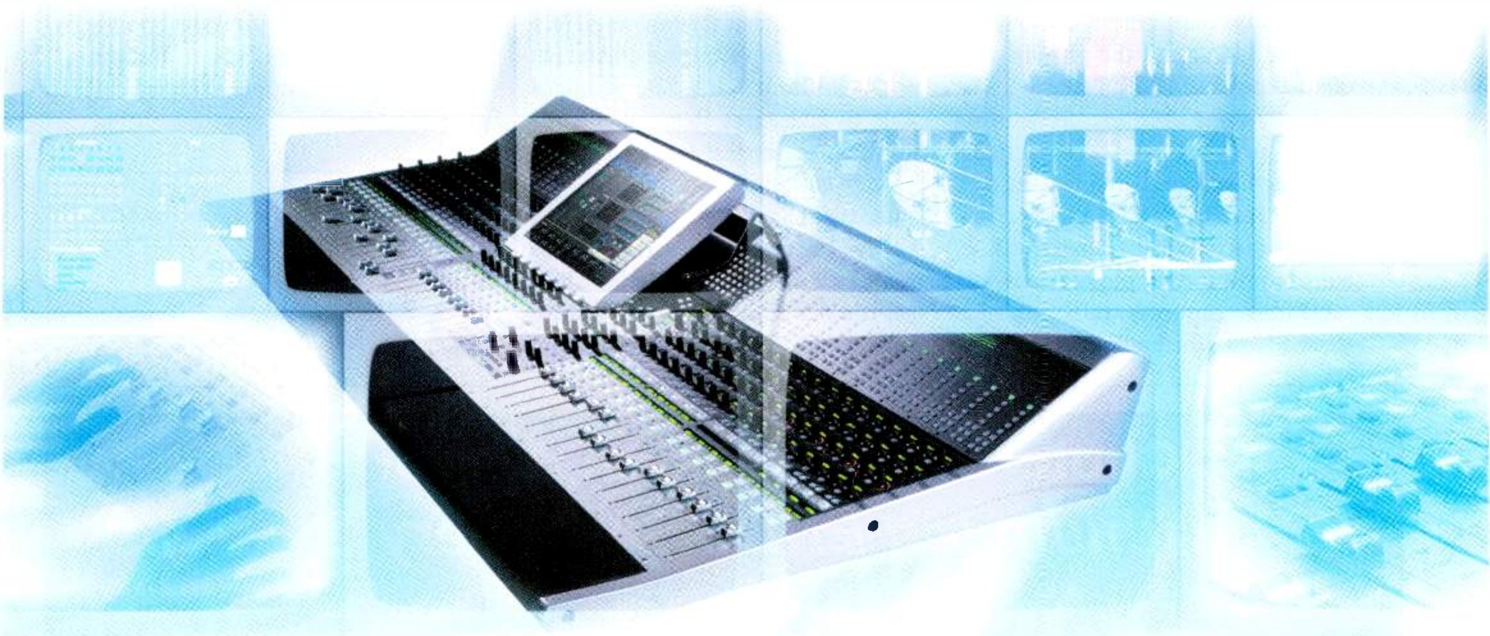


Figure 3. The AAL layer distributes application data into 48-byte cell payload blocks.

Digital Audio Within Your Reach



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and network-to-network interfaces (NNI). The ATM layer multiplexes cells from various applications (voice, data or video) into a single cell stream for presentation to the physical layer.

The physical layer is comprised of two sublayers: the transmission-convergence sublayer (TCS) and the physical-medium-dependent (PMD) sublayer. The TCS is responsible for controlling header errors, mapping cells into transport payloads and delineating cell boundaries. The PMD is the specification of the physical connections required by the specific physical medium.

ATM also supports traffic management (TM), which allocates network resources fairly and predictably for individual connections as specified by their QoS parameters. TM is enforced using traffic policing and shaping, connection-admission control (CAC), and congestion management. TM is one of the key capabilities that allows ATM to carry broadcast video over public networks. Without it, it would be impossible to guarantee that video traffic would be delivered at a consistent quality across the network, regardless of other traffic loads.

QoS can accommodate multiple traffic types with differing user requirements over a single infrastructure.

Three key QoS parameters for video service are cell-delay variation (CDV), cell-transfer delay (CTD) and cell-loss ratio (CLR). CDV is the variation in time between when you expect a cell to arrive and when it actually shows up. CTD is the overall delay across an ATM network. This is deterministic and predictable. CLR is the lost cells divided by the total transmitted cells. There is ongoing work in the Video Services Forum to determine the impact of CDV, CTD and CLR on video delivered across ATM networks.

As you learn about ATM, you may feel overwhelmed by three-letter acronyms (TLAs). Fortunately, there is an excellent glossary published on the Internet by the ATM Forum. You can find it at www.dit.upm.es/snh/arhelp/glossaries/atmf/. **BE**

Brad Gilmer is president of Gilmer & Associates, executive director of the AAF Association, and executive director of the Video Services Forum.

Send questions and comments to: brad_gilmer@primediabusiness.com

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Audio FX for video

BY ROBERT FRITTS

Sound effects are essential ingredients in video production. You can create an entire audio environment in a production by adding sound effects. The easiest way to add sound effects to your production is to use sound-effects libraries. In most cases, these libraries are on CDs that you load onto your digital audio workstation (DAW). In more sophisticated environments, these effects reside on hard drives so you can access them more quickly. Most libraries even have online search engines that allow you to find and download sound effects directly from the library's Web site. There are many different libraries on the market today containing thousands of effects ranging from war sounds like planes, gunfire and marching soldiers, to ambiences like love birds singing, jungle insects and frogs chirping.

Do it yourself

If the sound libraries don't have what you're looking for, the other option is to record it yourself. People who do this for a living are called Foley artists. Foley effects play a huge role in movies. Footsteps, door slams and a human skull being crushed by a giant monster are just a few of the sounds Foley artists create. One sound-effects library has released a set of CDs containing nothing but Foley recordings. But you can create a Foley studio yourself with some studio space and some common materials such as metal, wood, leaves, dirt and coconut shells, to name a few. The author recently enjoyed recording Foley effects for a DVD surround project. The video consisted of high-impact X Game sports footage of motocross, surfing, BMX, skateboarding and others. The challenge was to place the viewers on the motorcycle or skateboard, giving them the sensation that they were participating in those sports. This included recreating the sound that a skateboard makes grinding across a handrail and the sound of surfers gasping for air as a wave pummels them to the sea floor — all in the safe confines of a Foley studio.

You can create sound effects for your video productions with a video monitor, a good microphone, ordinary objects and a good imagination. People who do this professionally are called Foley artists.

Get real

Designing sounds for documentaries is especially challenging because it is imperative that the sounds be authentic. For instance, when sound designing the battle of Pearl Harbor, you cannot use the sound of a P-38 swooping down on the USS Arizona. Every war historian knows that the Japanese Zeros involved in that attack were powered by Mitsubishi engines. These engines and planes have a distinct sound signature, and it's a sound designer's job to recreate that sound. Fortunately, there is a library available that contains the sounds of Japanese Zeros and many other types of war birds.

The job of any sound designer is to be creative.

Henninger Digital Audio recently finished a documentary on NASCAR for the Discovery Channel. During the shooting phase of production, the sound designer brought microphones and a DAT recorder to a NASCAR event to attain a variety of sounds. The sounds ranged from mono engine revs and tire squeals to mid-side (MS) stereo recordings of race cars going down the back stretch at speeds of more than 150 miles per hour. As the race cars travel by, the rush of wind that travels past the microphones creates a dramatic Doppler effect. That particular recording has been used in a variety of ways. In one instance, a portion of it was sent pre-fader to a reverb unit and used for white-flash video transitions. The sound effect supports the video effect, and transports the viewer from one scene to the next.

Another project was a 30-second TV ad for "Washington Week in Review." The advertising objective was to make the political show sound riveting. The spot opens with a shot of a man sitting on his leather couch eating Chinese food and watching "Washington Week in Review." The subject's room is a large studio apartment with hardwood floors, a fish tank and an open window over the man's shoulder. We started sound designing

with broad stokes, creating an ambient base of sound effects and building up the drama as the spot went on. To accompany the fish tank and the open window, our sound-effects library supplied sounds of bubbles and light city traffic. To accompany the television, we recorded the sound track of one of the actual "Washington Week in Review" shows and equalized it. All the sounds were blended with a live hardwood reverb effect to mimic the acoustic properties of the room.

Get unreal

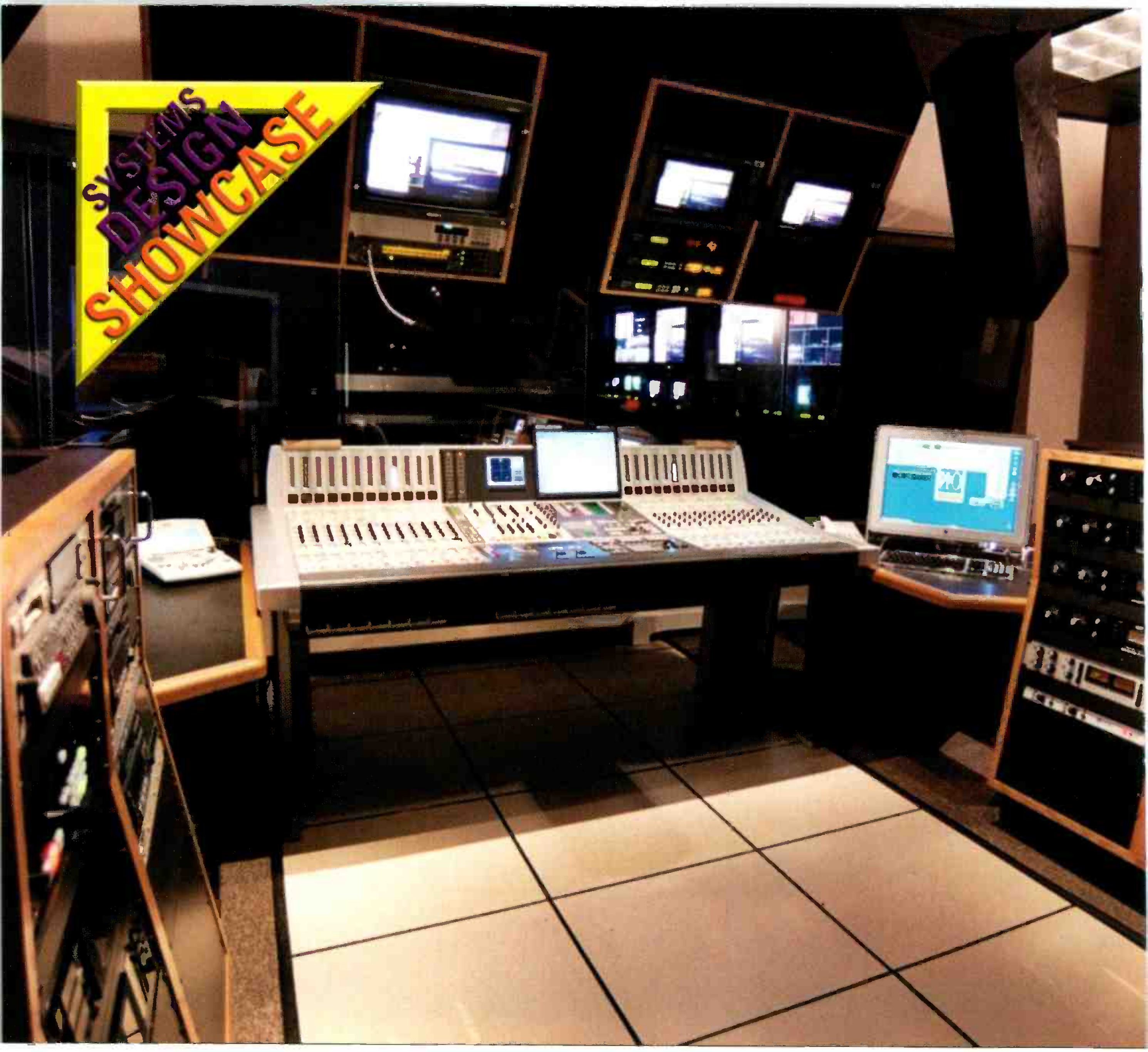
The next phase of the project was to record the Foley sounds. We needed the sound of the man eating his Chinese food and shifting his position in the oversized leather sofa. We also needed footsteps of an intruder climbing through the window and walking across the hardwood floor, the sound of the intruder removing a picture from the wall to reveal a safe, and then opening the safe. For the safe, we used the sound of a Craftsman ratchet wrench turning backwards. Another effect combined a whoosh, a cymbal played backwards and water from a faucet being turned off. All of these were sampled into a Kurzweil sampler to control the velocity and timbre of the overall effect. Then we bounced that sound from the sampler to our editor to position it to the timing of the video action.

Be creative

The job of any sound designer is to be creative. You must think outside the box and use many different sounds in combination with each other to create and support the video or film. Don't be afraid to experiment. Sample sounds into a synthesizer and cross-synthesize, modify, combine and modulate sounds with each other. Did you ever hear the sound of a digital Beta tape machine being rewound in shuttle mode? Add a flanging effect to that rewound sound and you've just created a futuristic sound for space travel. A synthesizer is a powerful tool for any sound designer. It gives you the flexibility to change the pitch, invert the sound and morph that sound into a completely different sound. Today, many of the new generation of DAWs have plug-in effects that add even more flexibility for the sound designer. Teams of designers can work on various scenes of the same movie sharing files and sounds and sending them back and forth to each other, giving the designer more time to be creative.

Always be aware of the sounds around you and how you can use those sounds to create even more amazing sounds. One of the most gratifying things a producer can tell you is that audio is his favorite part of the moviemaking process. BE

Robert Fritts is a sound designer/mixer for Henninger Digital Audio.



The transformation of WTVI-TV

BY WRAY WARE

WTVI in Charlotte, NC, has served the greater Charlotte/Meklenburg County since August 1965. It first operated strictly as a department of the Charlotte/Mecklenburg school system, becoming an independent community PBS station in 1983. The FCC mandate requiring all U.S. TV stations to convert from analog to digital transmission led non-commercial stations, such as WTVI, to prepare for their conversion deadline of May 2003.

While part of the goal was to meet that mandate, station management had a broader vision. They wanted to transform a 1990 vintage single-channel analog broadcast facility into a state-of-the-art multichannel digital facility that would go far beyond merely satisfying the FCC mandate.

There was a keen desire to have a fully functional HDTV and DTV facility rather than just a plain vanilla pass-through network that simply upconverted current analog programming to DTV. The station wanted to be able to originate digitally, live-to-air and edited-to-tape in both DTV and HDTV, with 5.1 surround sound.

The audio control room consists of Dolby-E broadcast implementation, which allows for surround sound throughout the production and broadcast process. Photos courtesy TGS.

The station has always had post-production facilities in Charlotte, serving a variety of outside clients within their funding guidelines. This helps offset the amount of public funds required to maintain an operation without interfering with their main mission of public television. Therefore, any transition plan for the broadcast plant had to also encompass editing facilities that provided full DTV/HDTV editing, complete with 5.1 surround sound production, and allow WTVI to maintain the same level of operations as in the analog world.

Streamlining operations was a key issue in planning for the facility, so as to minimize the need for operational funding from public sources. Automation played a key role in decisions made as the project moved forward, in order to allow the station to easily program multiple channels without staff increases.

Last of all, there was a need for clear documentation – a drawing and wiring database that would assist in making future upgrades and troubleshooting. This was sorely needed, as the analog plant had absolutely no wiring documentation at all.

In fact, the edit suites, live audio production room and audio post areas had to be rethought and redesigned to create spaces conducive to 5.1 audio production. HVAC and airflow had to be examined and tuned to minimize noise in several spaces. There were even changes in the studio, as 50 percent of the hard cyc was removed to improve the audio characteristics in the new studio.

Despite these kinds of changes, the desire was to keep the building modifications to a minimum. The entire project was funded by a government grant of ten million dollars, and WTVI wanted to preserve the lion's share of the grant for equipment and systems. To prepare for this project, the station extensively interviewed four systems integrators.

WTVI's goal was to transform a 1990 vintage single-channel analog broadcast facility into a state-of-the-art multichannel digital facility.

The challenge went well beyond a simple conversion. PBS facilities have a large library of analog material for iTV and other programming, so a large percentage of the existing analog plant had to be immediately converted to digital to interface with the new digital plant. In addition, there had to be the ability to deal with new formats as they might emerge.

In fact, upgradability was a major factor in the design process. This was not just a matter of buying the latest technology. It meant that each technology had to be evaluated for how it could grow, expand and absorb new technologies. Even the wiring layout and flow was carefully considered, making sure it was logical, clear and easily changed as the facility's needs changed. In many cases, the plant was pre-wired for future options to make those transitions easier.

There were acoustical challenges as well. This went beyond just adding acoustical treatments to walls.

Choosing an integrator was not simply a matter of determining whether the integrator was capable of this kind of cutting-edge project. They also had to be willing to work with WTVI, not as an expensive turnkey project, but rather as a partnership between the integrator and station staff. In the end, WTVI selected TGS of Chantilly, VA.

Multiple sources of public funding meant that the equipment list had to go out to bid, and so, in conjunction with TGS, WTVI deployed a large public bid with over 1000 line items. After evaluation, equipment was chosen and TGS began their work with the help of the station staff.

Master control is the nerve center of the broadcast plant. Built around the Philips (now Thomson) Saturn master control system and routing, it is designed to be run as a one-man operation, with easy access and control of automation, switchers and routing. Louth automation plays a

SYSTEMS DESIGN SHOWCASE

key role here, allowing one person to effectively stand watch over the multiple channels. During the day, these include four SD channels and, in the evenings, they include one HD channel and two SD channels. Master control is

Design team

WTVI-TV:
Wray Ware, chief engineer
Tom Green, senior maintenance engineer
Brent Kennedy, chief audio engineer
Thomas Brunet, maintenance engineer
TGS:
Joe Hickey, senior design engineer
Willy Halla, executive vice president for engineering

Equipment list

Thales Optimum liquid-cooled 2.5kW solid-state transmitter
Microwave Radio TwinStream 13GHz STL system
Discreet fire HD edit system
Discreet smoke SD edit system
Discreet SD edit system (Edit)
Studer D950B live audio console
Philips LDK 6000 HD studio cameras
Pixel Power Clarity HD graphics system
Accom Dveous HD DVE
Philips Seraph HD production switcher
Harris automation system
Myers Pro-Track traffic system
Sony HDW-700 HD field camera/recorder
Philips SD and HD Media Pool video servers
StorageTek cart archive system
Philips Venus router
Philips Saturn master control switcher
Philips Dune AES audio router
Panasonic D-5, DVCPRO VTRs
Sony HDCAM, Digital Betacam VTRs

HDTV editing is built around the Discreet Logic smoke platform, providing full HD capability, while SD editing is done in two rooms using the Discreet Edit system.

in a separate enclosed room away from the noise and activity of the machine core or major walkways, but the glass walls around this room allow touring groups to watch the operation of the station without disturbing the operator.

Studio control is designed to be functional with a logical workflow, and it provides the staff with the equipment they need at their fingertips. Monitor walls are actually Miranda Kaleido feeding four 42-inch plasma displays. This allows easy change of monitor setups for producers and programs, and keeps the monitor count down. The fully functional HD production room includes the Philips Seraph HD production switcher with two-M/E busses, which was chosen for its power and flexibility. There are also graphics and titles created in full HD by the Pixel Power Clarity HD graphics system, and effects built on the Accom Dveous HD and its industry standard user interface. Programs are produced in full 1080i HDTV, and can be sent to air as HD or recorded in virtually any format for use later by the station or clients.

In the studio are four Philips LDK

Studio control is designed to be functional with a logical workflow, putting the equipment the staff needs at their fingertips.

6000 1080i camera, ARRI lighting and QTV prompting, which is fully computerized and controlled from the control room or the studio.

Audio is also a major consideration. Because of the desire to be able to produce 5.1 audio at any stage of production or post-production, WTVI chose to put in place the first broadcast implementation of Dolby-E throughout. From the Studer 950 audio mixer, to the editing capabilities of the full Digidesign Pro-T 24 system, to the wide array of Dolby processing options, surround sound audio is available throughout the production and broadcast process.

There are three editing suites at the station. HDTV editing is built around the Discreet Logic Smoke platform, providing full HD capability, while SD editing is done in two rooms using the Discreet Edit system.

As programs and interstitials are completed, they can be stored and played back on a Philips (Thomson) Media Pool six-channel server, controlled via Louth automation. When programming is no longer needed immediately, it is archived to a StorageTek tape backup system, also controlled by automation and Avalon software.

The studio equipment consists of four Philips LDK 6000 1080i cameras, ARRI lighting and QTV prompting, which is fully computerized and controlled from the control room or studio.

Streamlining operations was a key issue in planning for this facility so as to minimize the need for operational funding from public sources.

The facility uses Harmonic HD and SD encoders for processing, and Thales stream management to groom the signal and add PSIP information. The signal is then sent to the Thales solid-state, liquid-cooled transmitter via Microwave Radio TwinStream radios for transmission on DTV Channel 11.

The master control is built around a Philips (now Thomson) Saturn master control system and routing, and is designed to be run as a one-man operation.

Great care was taken with the infrastructure. Different color wiring for each signal type is reflected in the final drawings, making follow-up and troubleshooting easier. The conversion and terminal gear is largely Miranda, ranging from DAs to conversion equipment to the Aquila upconverters. ADC patching boxed the router. Leader and Tektronix test equipment ensures quality control throughout the plant at key QC points.

Detailed pre-planning and engineering minimized problems, and made sure that all of them had fixes before the project was complete. In addition, extensive manufacturer training got staff on track once the systems were in place.

The facility went on air in April 2002, and has far exceeded the simple mandate of the FCC. But more importantly, it has met the larger goals of providing Charlotte with a facility that meets the multichannel challenge, providing up-to-date HDTV production and post-production facilities, and streamlining workflow and improving efficiency. **BE**

Wray Ware is the chief engineer at WTVI-TV.

Basics of waveguide selection

BY DON MARKLEY

Last month, this column discussed some of the fundamental concepts of selecting coaxial transmission lines. That included low-power flexible lines as well as some issues involving high-power rigid systems. It should be remembered that only the most elemental points could be covered in a short article. The actual selection of a large transmission line system is a topic that should be discussed at length by the station engineering staff with their consulting engineer. Look at it this way – the decisions made will directly concern the operating costs of the station for 20 years or more, and have a significant impact on the selection of a transmitter and can well involve an expenditure of as much as $200,000. When performing that evaluation of the transmission line system, the choice may well be not to go with coaxial lines at all but to move on to the more efficient but costly solution of waveguide.

Waveguide offers the advantages of lower loss and extremely high power handling capability. On the negative side, the cost is higher, the installation somewhat more demanding and the wind load on the tower is usually higher than that for coaxial line. Again, the total analysis and selection process must include the impact of the efficiency on the transmitter selection along with tower capability, system cost, system reliability and the real cost of money for the purchase of equipment. Waveguide systems don't use sliding inner connections or wristwatch bands that need to be replaced regularly. Absent external mechanical damage, they will outlast anything else in the transmission chain.

Waveguide offers the advantages of lower loss and extremely high power handling capability, but with higher costs and more demanding installation.

Most station engineers don't really understand exactly how waveguide works. Honestly, it is difficult to explain without digging deeply into some rather rigorous math. In its simplest form, think of a waveguide system as an antenna that is transmitting the signal into good old free space. In this case, the space isn't really free but is bounded by the sides of the waveguide. Rather than being allowed to freely expand in all directions, the electromagnetic field is contained within the waveguide (hence its name) and is required to radiate only in the direction permitted by the boundary of the walls of the waveguide. At the other end, another antenna is used to receive the energy and couple it to the desired load.

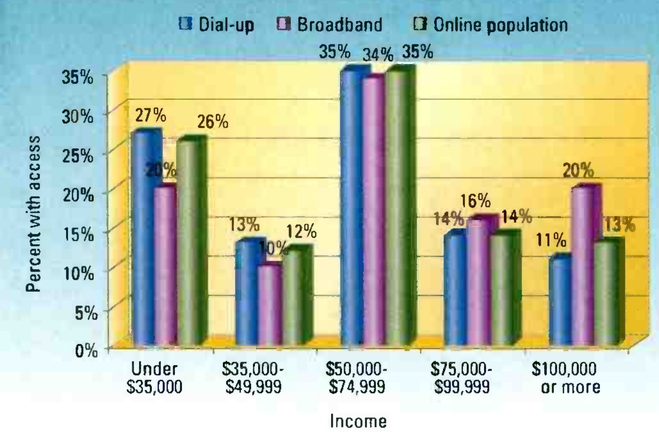
Over the years, numerous configurations have been tried for waveguide, each with its own set of advantages and disadvantages. The most common type is rectangular, both in the mathematics and in operation. All waveguide is capable of operating with different modes of electrical and magnetic field distributions inside the boundaries. Each of those modes normally has a maximum and minimum frequency at which the mode can exist. Those are called the cutoff frequencies of the waveguide. That is, operation will not exist with that mode of field distribution above or below those cutoffs.

FRAME GRAB

A look at the consumer side of DTV

Internet dollars

Technology access still tied to income



SOURCE: Jupiter Research *www.jupiterresearch.com*

Normally, the cutoff frequencies for various modes overlap somewhat, which can result in the signal changing its characteristics as it transverses the waveguide. That is not usually something to be desired. It can be a real problem when attempting to couple the energy back out of the waveguide. An example of this is found in large coaxial cables. At high frequencies, the cable starts to act like a waveguide and the apparent cable loss increases drastically. That doesn't really mean that more signal is being lost by normal attenuation – simply that the energy can't be properly removed from the cable by a standard connector. In practical terms, the cable becomes unusable at such frequencies, creating a maximum usable frequency in practice.

The solution is normally to operate the waveguide at a frequency where only the simplest of modes can exist. While not necessarily the best in terms of efficiency, such operation is very stable and is least affected by the minor variations that must occur in any waveguide, whether by expansion or minor discontinuities.

All waveguide is capable of operating with different modes of electrical and magnetic field distributions inside the boundaries.

Next is the geometry of the waveguide itself. Numerous combinations have been tried and some have special advantages for special needs. The most common is rectangular where the broad dimension is twice the narrow dimension. This has been varied in similar types all the way to fully square with some waveguides having notches in one or more walls. Those special types have little application in broadcasting and essentially none in long vertical runs. Elliptical waveguide has long been popular in semi-flexible systems for microwave use. With either a smooth or grooved wall, these are easy to install, relatively inexpensive and very efficient. The large size needed for UHF television frequencies can create real problems in trying to make semi-flexible elliptical waveguide. Primarily, the mechanical problem of making such a large line both flexible and capable of standing the normally anticipated mechanical loads rules out practical construction. However, Myat is now producing an elliptical rigid waveguide for UHF television.

The other non-rectangular waveguides that are popular are the fully round waveguide from Andrew and the truncated elliptical waveguide from Dielectric. Both of those systems work very well with their own advantages. The fully round Andrew waveguide is normally used only for the straight vertical run. Andrew has made elbows but their difficulty doesn't seem to be worth the trouble. The main run, where the most loss occurs, is the vertical portion. Therefore, Andrew transitions from round to rectangular waveguide at the top and bottom of the vertical run. The rectangular waveguide is then either used to connect directly to the antenna or coupled back to coaxial line to the antenna. At the bottom of the tower, conventional waveguide elbows and sections are used to go into the building to the internal RF plumbing. Based on published data, and theoretically, the totally round waveguide is the most efficient. However, the system efficiency must also include the lesser efficiency of the rectangular waveguide and/or coaxial transmission line at each end. The round vertical run also is a bit better from a wind load consideration than the rectangular waveguide with its flat sides.

In the past, the primary problem with round waveguide has been the rotation of the mode inside the waveguide during the vertical run. As the waveguide expands when heated by the sun, it tends to decouple the transition at the top, resulting in reflections and ghosts. Andrew has solved that problem by inserting pins across the waveguide. Those pins force the fields to maintain the proper orientation and eliminate the mode change problem.

The Dieletric truncated waveguide allows the transition from coaxial cable or rectangular waveguide to be made in the transmitter room.

The truncated elliptical waveguide from Dielectric does make full use of elbows. Therefore, the transition from either coaxial cable or rectangular waveguide can be made in the transmitter room. The complete run then is waveguide for both the horizontal run and vertical run. While the truncated elliptical efficiency is less than for the purely circular, the elimination of the rectangular waveguide for the horizontal run compensates for much of the difference. The truncated waveguide is enclosed in a round cover that brings its wind load down to essentially the same as the round waveguide. The shape of the waveguide, as for rectangular, stops any change of the mode with minor expansion.

The round waveguide does not require tuning in the vertical run, although it is necessary at the transitions at each end. For the truncated elliptical waveguide,

tuners are inserted periodically to compensate for minor reflections. Tuners are also used when necessary for rectangular waveguide, especially at or near elbows. That brings up a major point. Waveguide is tuned by distorting it. That is, either a reflection is introduced into the waveguide by inserting a tuning probe or the walls are intentionally flexed by applying pressure to specific points. That indicates the necessity of treating the waveguide carefully during installation. If it is dented, it is mistuned. The system must be installed very carefully to prevent any mechanical damage. That is one advantage of the cover over the truncated elliptical waveguide. The cover is not part of the waveguide electrically and shields the inner part of the waveguide from damage.

Another critical part of the waveguide is the assembly at flanges. The flanges on waveguide are very carefully machined to make the junctions as smooth as possible. Therefore, the alignment of the flanges is critical. Normally, the proper alignment is accomplished through the use of pins, which are used to force the correct positioning. For optimum performance, the entire installation has to be done with a great deal of care. A careful measurement of the system performance and final tuning is absolutely necessary for the best possible operation.

Finally, the problem of pressurization. No, you can't just hook up the old nitrogen bottle and dump in five pounds or so. To do so will flex the walls of the waveguide, changing the tuning significantly. The best solution to the problem is to use a dehydrator system specifically designed for waveguide. Such a system only applies a pressure of a fraction of a pound. Then, a dump valve is used to let off pressure when the waveguide is heated by the sun. When it cools off at night, the dehydrator adds air to maintain a steady pressure. Remember, it is the effect of the sun on the waveguide that primarily causes pressure change. The power rating of waveguide is so much higher than TV transmitters will provide that the RF has very little effect on the waveguide temperature.

When properly selected, installed and tuned, waveguide systems provide the best possible efficiency, performance and lifetime. If the suits in the front office get too concerned about the price, tell them it is used to carry the heat from the transmitter up the tower to reduce the air conditioning load and expense. That they can understand. **BE**

Don Markley is president of D.L. Markley and Associates, Peoria, IL.

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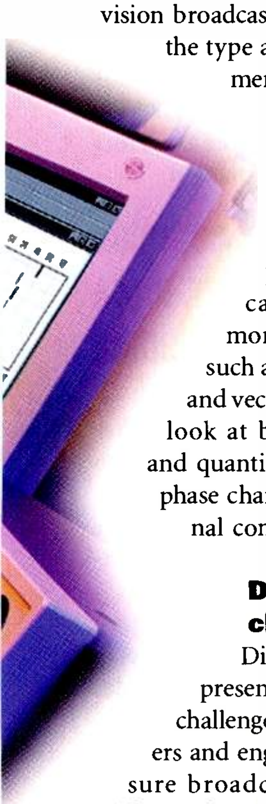
Multilayer monitoring for DTV

BY GREG HOFFMAN

Just as with analog broadcasting, digital broadcasters need to monitor their signals to anticipate problems.



As the television broadcasting industry makes its transition from analog to digital technology, the traditional means of ensuring broadcast quality and reliability are no longer adequate. Fundamental differences between analog and digital architectures introduce system behaviors that demand a new monitoring approach, with new procedures and tools.

Analog television signals represent video and audio as a continuous range of voltage values that can assume an infinite number of states. Imperfections in the distribution or transmission channels can produce noticeable errors in the picture or sound, but there is some tolerance for these errors. Although quality steadily declines with increased degradation, the content remains intelligible even in the presence of substantial errors.

The virtue of analog technology is that experienced broadcast engineers can recognize the onset of channel impairment simply by viewing the television broadcast. They can diagnose the type and degree of impairment and take corrective action before quality degrades to an unacceptable level. For more precision and repeatability, engineers can turn to analog monitoring instruments such as waveform monitors and vectorscopes. These tools look at baseband waveforms and quantify the amplitude and phase characteristics of the signal components.

Digital challenges

Digital television signals present a new and different challenge to broadcast producers and engineers who must ensure broadcast quality. Digital video and audio information is delivered as a discrete but finite set of values. Digital content is relatively impervious to minor imperfections in the channel; picture and sound quality remain acceptable until impairment level reaches a certain threshold. Beyond this point, the "cliff effect" occurs: signal quality drops off drastically, or the picture disappears altogether from the viewer's screen.

In the digital broadcast environment, engineers cannot detect the onset of channel degradation by watching the broadcast; they can only react to severe quality problems once they appear — when it is too late.

Monitoring

Digital broadcasters need monitoring approaches that let them anticipate problems, just as they could with their analog broadcast content. They need to address channel degradation before it leads to noticeable quality problems.

A new generation of digital monitoring instruments has emerged to answer this need. These confidence-monitoring tools help broadcasters achieve the same level of confidence in digital television that they achieved in analog. Ultimately, digital technology can deliver a better product to end users. Confidence monitoring helps the technology live up to that promise.

Distribution

Digital technology is the foundation for the convergence of video, voice and data-distribution systems (networks). Digital telecommunication-network operators gain new sources of revenue by offering distribution services to broadcasters, and broadcasters can use these services to reduce operating expenses.

These arrangements introduce additional transitions in the distribution chain. When content passes from one broadcaster to another, the responsibility for quality control goes with it. Both broadcasters must rely on contractual quality of service (QoS) obligations to preserve the content on its way to end users. Clearly, this complicates the process of maintaining quality.

System management

Digital convergence enables broadcasters to take a new approach to system management. It allows them to adopt and adapt the centralized monitoring and management model that has worked so efficiently in the telecommunications industry. New digital video broadcast management systems will rely on network-capable confidence-monitoring devices that can report networkwide status and send alarms to a central video network operations center.

In the digital broadcast environment, engineers cannot detect the onset of channel degradation by watching the broadcast.

The digital cliff effect, the increased number of transmission handoffs, and new centralized management approaches are influencing the requirements for confidence-monitoring systems in digital television. The latest generation of tools integrates the solutions for all of these challenges.

Confidence monitoring

One of the biggest architectural differences between an analog television system and its digital equivalent is the "layered" architecture that is central to the entire digital distribution/transmission chain.

In an analog television system, distribution and transmission channels are, in effect, a series of analog signal-processing steps. But, with digital technology, broadcasters can use signal- and data-processing techniques to improve quality of their product and the efficiency of their networks. Hence, distribution and transmission channels in digital television systems contain sequences of signal-processing and data-processing steps.

Figure 1 shows the layered digital-system model. Table 1 summarizes the signal- and data-processing steps for these layers.

Quality-control challenges within the layers

So far we have shown that the digital video broadcast architecture is made up of three layers. In each layer, signal- and

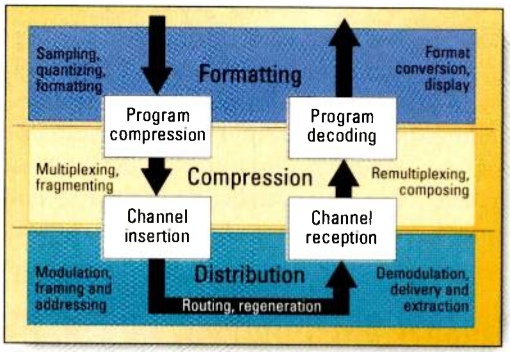


Figure 1. This graph shows the three layers of digital television broadcast.

data-processing steps can add errors.

From source to consumer, program content may move through each of the three system layers several times. Transitions between layers can dramatically alter the nature of the digital information. For example, the uncompressed digital video data in the formatting layer is entirely different from the compressed digital video in the compression layer. The additional processing needed to move across layers increases the probability of quality errors at these transitions.

In the formatting layer, broadcasters must accommodate the variety of new formats for both standard- and high-definition digital television. As with analog television, they need to ensure correct colorimetery and verify conformance to standards. In addition, they may need to convert from one format to another, as in downconverting HD content for broadcast on an SD system. These format conversions can introduce quality errors. Lastly, separate processing of digital video and audio can lead to synchronization problems.

In the compression layer, broadcasters must confront an entirely new architecture that differs dramatically from analog television. Compression introduces new types of quality defects such as blockiness, in which some areas of the picture split into granulated areas. Errors can occur during the complex process of multiplexing programs and system information into a single datastream. Errors in timing and synchronization parameters can compromise the decoding process and lead to noticeable content-quality errors.

In the distribution layer, broadcasters encounter familiar RF technology in the transmission networks. But these systems use different modulation techniques and offer new challenges in understanding coverage and interference problems. For internal distribution, broadcasters increasingly rely on telecommunication technology, which introduces problems with latency, packet loss and synchronization.

Compounding all these potential problems, errors in one layer can cause errors in a different layer and obscure the original error source. For example, blockiness errors can arise from problems in the compression

As always, the way to handle a big, complex challenge is to split it into smaller, more manageable pieces.

layer, or as a byproduct of uncorrected bit errors in the receiver (distribution layer). There is no visible difference in the appearance of these errors, despite their different origins.

As always, the way to handle a big, complex challenge is to split it into smaller, more manageable pieces. Electronic repair technicians will attest to the effectiveness of this method. Fortunately, the digital video architecture lends itself to this approach. By monitoring discretely the behavior of each layer, it is possible to control the quality of the video signal as it progresses through the system, preventing the buildup of errors. This practice, which is rapidly gaining acceptance in the digital broadcast industry, is known as distributed multilayer confidence monitoring.

Distributed multilayer confidence monitoring

A well integrated confidence-monitoring system can deliver both quality-control and system-management functions:

- Layer-specific probes and tools detect the errors before they propagate from layer to layer.
- Multilayer monitoring makes it possible to quickly isolate the root cause to its origin within a specific layer.
- Extended monitoring capability alerts engineers to system degradations before they become quality problems.
- Network control supports system-management strategies.

Let's take a look at how you might deploy multilayer confidence monitoring in your broadcast system. Figure 2 shows a very simplified version of a digital terrestrial television broadcast facility and the potential monitoring points, which include:

- MPEG monitoring at the multiplexer output to detect data rate problems, protocol errors or errors in inserting PSIP information
- MPEG monitoring at the other end of the studio-transmitter link to detect PCR jitter problems
- RF monitoring at the transmitter site to detect degradations in transmitter performance
- Waveform monitoring, picture quality monitoring or A/V delay monitoring at master control to detect potential errors before you compress, multiplex and transmit.

Layer-specific monitoring probes

In a confidence-monitoring system, each monitoring device acts like a probe,

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monitoring quality at a particular point and layer in the distribution or transmission chain. No single tool can span all of the layers and processes, but some tools offer powerful networking and integration features to aggregate the information from diverse probes. Each layer has its own specific toolset.

At the formatting layer, digital waveform monitors help broadcasters detect quality problems. Like their analog counterparts, these probes monitor characteristics of the digital video signal. Other formatting layer tools include digital audio monitors, picture-quality monitors for detecting blockiness and other picture impairments, and probes for detecting audio/video delay.

At the compression layer, processing must adhere to MPEG-2 standards. Broadcasters need MPEG protocol monitors capable of detecting problems in the basic MPEG processing, as well as the additional processing defined in the DVB, ATSC or ISDB broadcasting standards based on MPEG. The signal should emerge from the compression layer fully compliant with MPEG requirements and any contractual QoS policies.

Layer	Signal processing	Data processing
Formatting Television content providers create and format the video and audio that the broadcaster will deliver to the consumer	· Sampling, quantizing, and formatting steps needed to create digital television signals · Conversion between digital formats · Displaying a digital signal on a television set or picture monitor	
Compression Content providers and broadcasters compress and aggregate content for storage, distribution or transmission	· Video and audio compression	· Multiplexing programs and system information into a single datastream · Fragmenting the stream into a packet protocol · Recomposing programs from packets for decoding
Distribution Broadcasters process content for distribution over internal networks or delivery to the consumer through digital television transmission systems	· Modulating digital signals onto RF carriers	· Error-correction algorithms for transmission · Formatting to embed content into the network communication protocols used in internal distribution

Table 1. This is a summary of the signal- and data-processing steps involved in each of the three layers of digital TV.

Multilayer monitoring

Each layer has its own unique probing and analysis solutions. Since errors can arise in any layer, all three layers must be probed. Tracking only the compression layer, for example, will detect problems in that layer. But the problems might have originated in another layer. There is no way to determine problems' sources unless each layer is monitored separately.

To gain a complete picture of system quality, and to quickly detect and isolate quality problems, broadcasters must rely on multilayer confidence-monitoring solutions.

Confidence-monitoring processes must detect and display the small clues that predict an imminent fall from the digital cliff.

At the distribution layer, broadcasters need probes to detect quality problems in a variety of distribution and transmission channels. Probes in this group include devices to monitor RF transmissions in DVB, ATSC or ISDB formats. They also include probes for monitoring information sent through either cable or fiber telecommunication networks.

Extended monitoring capability

A confidence-monitoring system is a valuable asset for broadcasters. It helps them efficiently locate, analyze and correct problems that affect video quality. Basic confidence-monitoring probes within the system track a small set of key quality parameters and provide an "indicator light" (actually a selection of screen displays and alerts) to tell the broadcaster when something has gone wrong.

But basic confidence-monitoring probes do not offer a complete solution. What is missing? Most importantly, the information needed to prevent objectionable quality problems in the content. Confidence-monitoring processes must detect and display the small clues that predict an imminent fall from the digital cliff. Moreover, the processes must support a proactive approach to quality control with timely alerts, alarms and documentation. This situation calls for extended confidence-monitoring probes. These tools use more advanced analysis to make additional measurements of quality parameters.

To understand the distinction between basic and extended monitoring tools, consider RF transmission monitoring. Basic RF confidence monitors measure the bit-error rate (BER) of the signal. BER will remain low — and apparently safe — until the transmission approaches the digital cliff. But the BER increases dramatically as the transmission falls off the cliff. This gives broadcasters only slightly more time to react than they would have if they watched the transmission on a picture monitor.

Extended RF confidence monitors add more detailed measurements such as modulation-error ratio or error-vector magnitude. These qualitative measures decline more gradually as system performance degrades. The monitoring tool notes this decline and sends an alarm to the engineer in time


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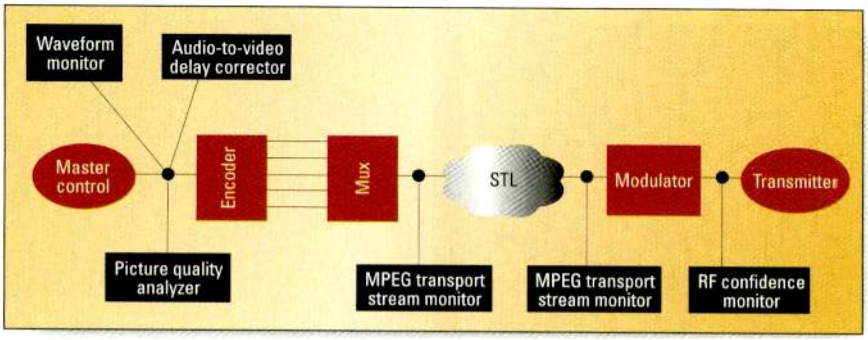


Figure 2. This figure shows how you might deploy multilayer confidence monitoring in your broadcast system.

to make adjustments or seamlessly transition to backup systems.

Network control and system management

System management concerns are a part of any confidence-monitoring strategy. The "system" may extend beyond the master network facility and reach out to far-flung regional distribution centers, as Figure 3 shows. Broadcasts sent to these regional centers via airwaves may need to be monitored to ensure that the program material reaches end users in good, unimpaired condition.

A distributed network benefits from distributed monitoring. Status data and alarms go to a central network operations center via the Internet.

In another scenario, the master facility may receive contribution feeds over a telecommunication network. Because a third party (the network operator) is involved, there will be contractual QoS levels that must be verified. The broadcaster may install confidence-monitoring probes at the network operator's points of presence to assist in this process.

Both scenarios call for flexible networking capability in the probing tools. If these features include Internet connectivity, they offer a ready-made solution for monitoring distributed sites no matter where they are located. They can easily report status and alarm conditions to the master location. An RF monitor, for example, could quickly notify engineers of increases in BER at a transmission site hundreds of miles away.

Form factor and cost are also important considerations in a confidence-monitoring system. Large, card-modular solutions are appropriate in central facilities with a large number of signals and multiplexers. These full-featured tools are usually configurable for every conceivable monitoring need. Smaller, more specialized, single-channel probes are usually preferred for work in remote locations such as transmitter sites. And smaller yet are the handheld confidence-monitoring probes that fulfill the needs of installation and maintenance teams. Although handheld probes are more limited in functionality, they too may offer networking features to connect the technician with the central plant.

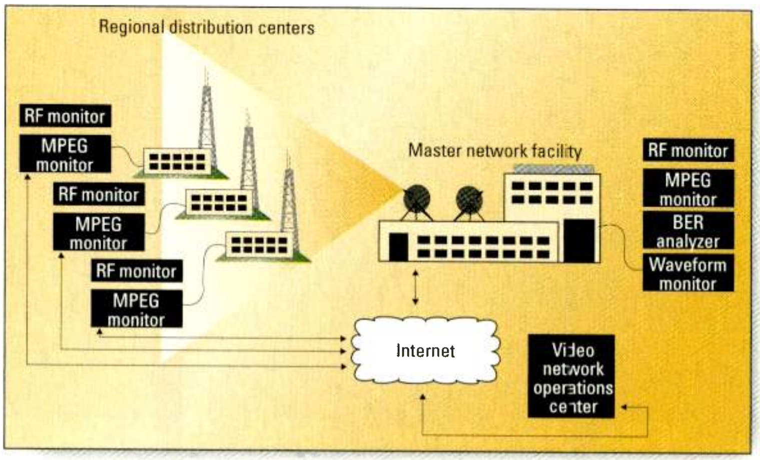


Figure 3. A distributed network benefits from distributed monitoring. Status data and alarms go to a central network operations center through the Internet.

The concept of extended, multilayer, distributed monitoring with appropriately scaled tools is the key to ensuring competitive quality levels in tomorrow's all-digital broadcast networks.

Digital broadcast technology is changing the way the industry creates, processes and distributes content. At the same time, certain characteristics of digital architecture —particularly the digital cliff effect — are influencing the monitoring methods broadcasters use to ensure quality throughout their systems.

Increasingly, broadcasters are discovering that multilayer confidence monitoring is the best insurance against unforeseen failures in digital broadcast systems. They are installing layer-specific probes to deliver timely details about the behavior of a signal as it passes through the formatting, compression and distribution layers.

New types of monitoring probes are arriving with extended monitoring capabilities to help broadcasters proactively address performance degradations before they become quality problems. And networking features such as automated status reporting and alarms are enabling broadcasters to develop systemwide monitoring and management procedures.

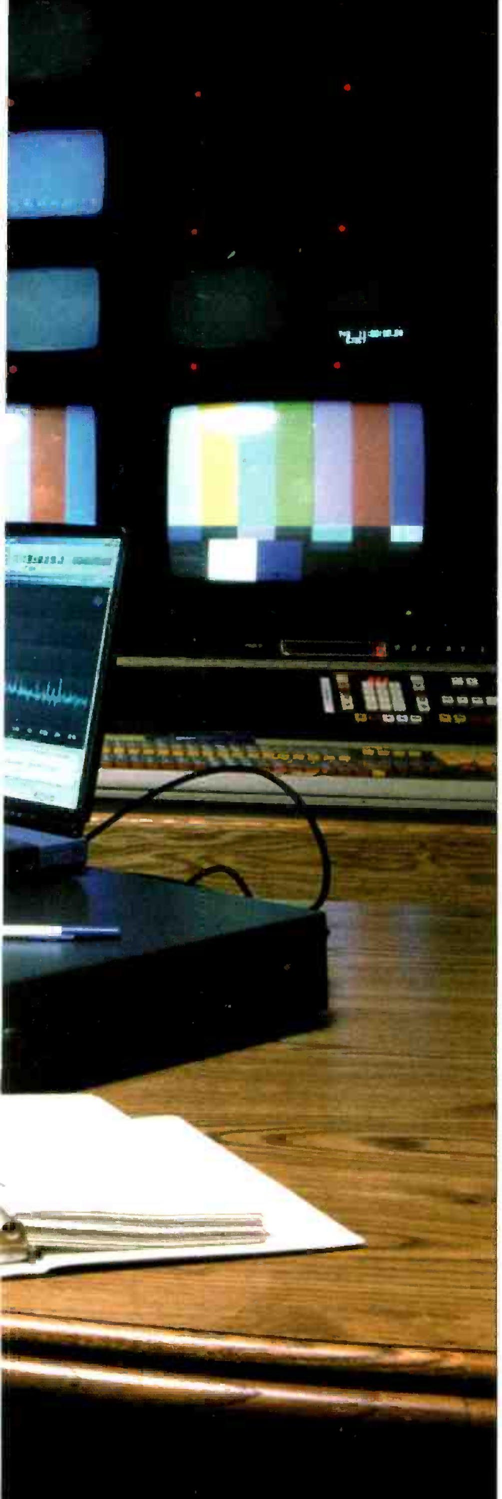
All this monitoring and management goes on behind the scenes, as it should. The critical result is that end users receive content that lives up to the promise of digital television broadcast technology. **BE**

Greg Hoffman is a product marketing manager for Tektronix.

Pat Shearer, chief engineer at KWBP in Beaverton, OR, monitors the quality of the station's audio signals from the studio control room.

Digital audio measurements for broadcast

BY WAYNE JONES



Transmitting and storing audio signals in the digital domain is well-established in the broadcast industry. Analog audio has given way to the AES3 and Sony/Phillips Digital Interface Format (SPDIF). AES3 datastreams are also embedded in SDI television signals.

Handling audio in the digital domain offers many advantages over analog methods. An analog signal incurs progressive degradation as it passes through a chain of circuits. Converting the analog signal into digital and converting back to analog as late in the chain as possible overcomes this degradation.

But keeping audio in a digital format does not automatically guarantee perfection. The notion that a signal comprised only of ones and zeros is immune to degradation is seductive, but misleading. Digital signals are affected by crosstalk, noise, cable length, poor circuit design and other factors that can ultimately translate into audible problems.

Many of these mechanisms of degradation are not obvious. This article describes what can go wrong, what effects to look for and what you can do about it.

First, let's take a look at the digital audio signal itself so we can better understand how problems can develop. The AES3 digital interface format was initially designed to simplify the transition from analog to digital in a studio environment. Its designers recognized that studios had a large investment in signal-transmission infrastructure, specifically in two-conductor, shielded cables interconnecting systems, equipment and studios. So the standard uses a self-clocking, polarity-insensitive technique to allow studios to transmit digital audio over these existing cables.

Conventional digital signals at the circuit level commonly define a logic "high" or "one" as a particular absolute voltage level, perhaps +5V, and a "low" or "zero" as 0V. Such an interface format is polarity-sensitive and would be difficult to use in a studio environment that might have occasional inadvertent polarity inversions in infrastructure wiring.

The notion that a signal comprised only of ones and zeros is immune to degradation is seductive, but misleading.

To circumvent this problem, the AES3 interface relies on level transitions rather than absolute levels to define logic states. It defines a "unit interval" or UI as the smallest quantized time interval in the format. At the common 48kHz sample rate used in professional digital audio, this interval is 163ns long. The standard says that if the signal level remains unchanged for two UIs, the logic level is a zero; if it changes state from one UI to the next, the logic level is a one.

AES3 defines the actual protocol of the serial datastream representing the digitized audio signal. Figures 1 and 2 illustrate the sequence of the serial data bitstream. It starts with a preamble — a series of bits that identify the start of a frame, a subframe or a block. The next 24 bits are reserved to represent the audio signal. Finally, at

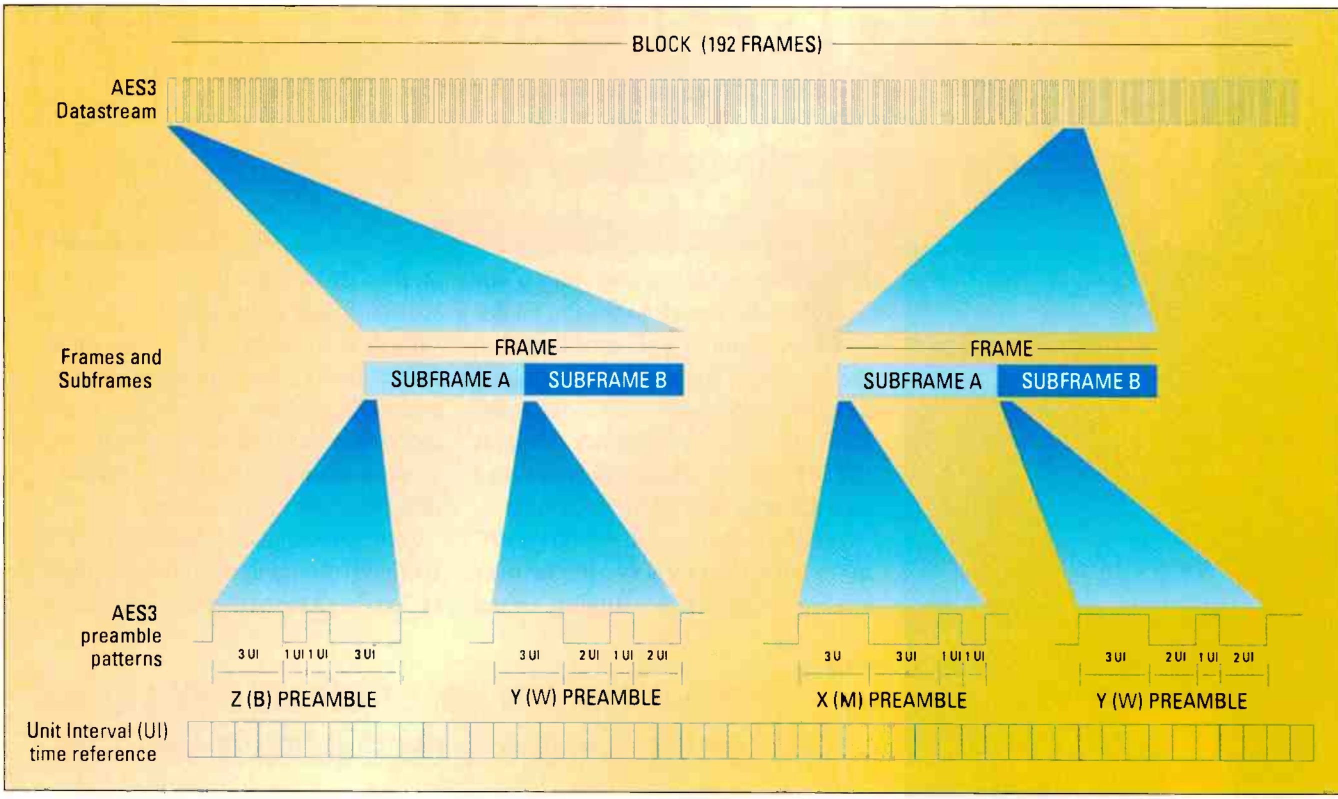


Figure 1. This breakdown of the AES serial data bitstream reveals the frames and subframes and their components.

the end of the sequence are administrative bits that identify characteristics about the data itself, such as sample rate, consumer or professional format, linear or compressed audio, and other information.

What can go wrong?

Some common errors include incorrect sample rate, excessive jitter, insufficient amplitude, poor data integrity caused by incorrect termination, or the use of poor cable. There can be problems in the analog-to-digital conversion process itself, although the quality of converters has progressed substantially. The most common design implementation used for converters these days uses an over-sampling technology. This method can substantially reduce residual noise and distortion by using a noise-shaping technique that shifts the noise upwards in the spectrum beyond the audio band. But, in return, it does produce substantial "out-of-band noise" that can cause problems in some areas. Good practice suggests that these out-of-band components be filtered out at the source before they can pollute subsequent devices. Being aware of possible artifacts can help when troubleshooting obscure problems.

Sample rate shouldn't be a problem — provided you use the correct rate. Two sample rates are in common use: 48kHz in the professional environment and 44.1kHz in the consumer world. One scenario that can cause problems is if a faulty transmitting device has a sample rate sufficiently different from what it should be. This could prevent a subsequent device from locking onto the signal. Or perhaps someone is using the incorrect sample rate, perhaps 44.1kHz instead of the required 48kHz. Sample-rate converters can correct the latter problem.

Jitter is perhaps the biggest problem in digital audio transmission. As mentioned earlier, the AES3 bitstream is self-clocking: The AES3 receiver derives its clock from the transitions of the datastream itself. If the interface pulses received were perfect rectangles, the time of the fast-rising vertical transitions would be clearly defined. But because the cable has capacitance and the AES3 transmitter has finite source impedance, the level transitions have a finite rise time. Since modulation of the datastream typically produces asymmetrical level states, the DC level of the interface waveform shifts with the data content.

Figure 3 shows how these facts affect the zero-crossing detection time. As the DC value moves up and down with time, the transition time, and thus the embedded clock edges, vary. This variation from cycle to cycle results in

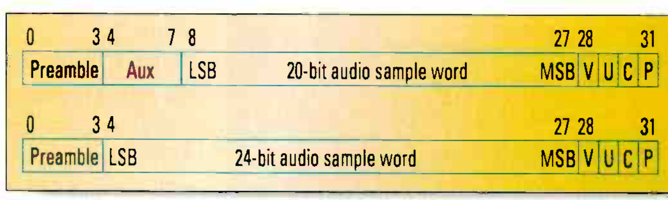


Figure 2. Each block of audio data contains a preamble, the audio information and administrative data.

a constantly varying phase shift called cable-induced clock jitter. This problem can be reduced by using a cable specifically designed for AES3 transmission, rather than standard microphone or analog audio cable. Most cable manufacturers make such a cable with the correct 110Ω impedance. It's important to have the cable properly terminated at the far end. Data-pulse integrity, unlike analog-signal transmission, is affected by proper source, cable and termination impedances. Figure 4 shows an AES3 datastream with and without proper termination.

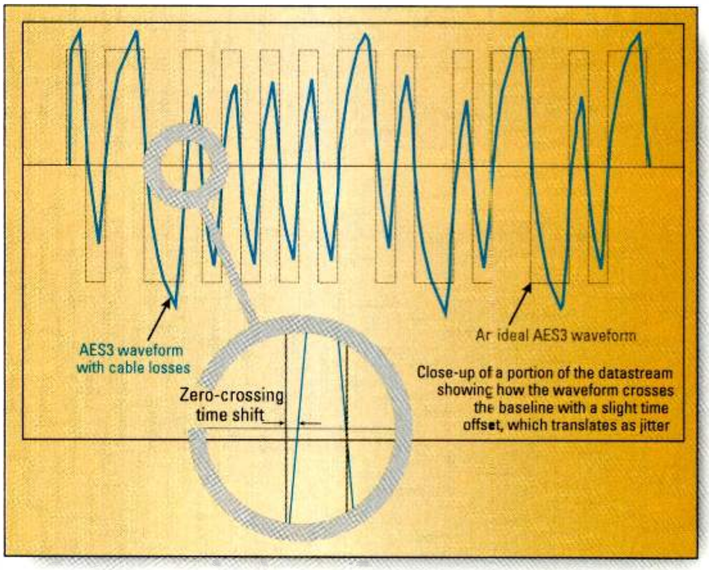


Figure 3. This diagram shows how the cable's capacitance and the transmitter's finite source impedance affect the signal's waveform, which in turn affects the zero-crossing detection time.

Jitter can also be caused by noise or crosstalk added to the datastream. The noise or crosstalk will cause ambiguity in the zero-cross transition of the data pulses, again causing jitter. In a broadcast facility, program synchronization is very important. To ensure a common time reference, "house sync" is typically distributed and used by all systems. If there is jitter on this clock signal, it can be transferred to any audio device that uses it in the process of trying to maintain audio/video synchronization. Another phenomenon, "jitter accumulation," occurs when several digital devices are cascaded — a common situation in a broadcast facility. Each device can pass on the jitter it receives while adding its own accumulation of jitter.

Jitter is perhaps the biggest problem in digital audio transmission.

So why do we care?

How can jitter affect audio performance? Jitter components, be they broadband noise, specific frequencies caused by crosstalk, or any of several other sources, can show up in the recovered analog audio signal. An FFT spectrum analysis of a recovered audio signal would reveal any crosstalk and noise components due to jitter accompanying the signal. The digital-to-analog converter usually uses the clock signal extracted from the digital datastream as its sampling clock. In such cases, the jitter will modulate the conversion process. This can raise the noise floor or add unwanted frequencies to the audio signal.

More seriously, if jitter reaches too high a level, some data receivers will begin to malfunction, eventually losing lock. Often, this situation may occur in a large facility due to a particular interconnection of several subsystems with the resulting jitter-accumulation effect. This makes after-the-fact maintenance difficult. The trouble report may describe an intermittent signal loss, but, when the troubleshooter assesses the final device in the chain, he can find no fault because the complete path is no longer intact.

What can be done?

It is not possible to see jitter by looking at a time-domain waveform; the sync circuits of a conventional oscilloscope are agile enough to follow the jitter in the signal and display a stationary waveform. Fortunately, there are several diagnostic and analytical tools available. Stand-alone AES3 data analyzers are available, as well as complete audio-measurement systems that include sophisticated data-integrity-measurement functions. Such instruments measure the level of jitter directly, usually expressing the result in UI or time. They also usually measure the more obvious, but nonetheless, important, parameters like data signal level and sample rate.

A particularly valuable test is an "eye pattern" display. This function averages multiple pulses and displays a statistical average. The measurement system extracts the clock from the datastream but regenerates it using a phase-locked loop to produce a "perfect" clock reference — free of jitter but of the same frequency and phase as the embedded clock. This reference synchronizes the display, but the actual datastream is displayed without correction and thereby shows its actual jitter. If the signal were perfect, the display would be a rectangle with thin traces. A real-world signal will show a rise time and the jitter, all of which result in a display with fat traces as several successive pulses are overlaid. The rise time gives a triangular appearance to the display, which is where the term "eye pattern" comes from. The size of the opening in the center of the eye directly measures the integrity of the signal. Slow rise times and high jitter make the opening smaller. The AES3 standard defines a minimal eye size for reliable performance. Figure 5 shows a typical eye pattern with an AES3 limit shown in red.

In addition to characterizing an AES3 datastream with such an analyzer, data impairment simulation allows you to

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evaluate how robust a device is when presented with a data signal that has noise, jitter and other problems. A sophisticated digital-domain audio analyzer usually includes the ability to add calibrated amounts of data-signal impairments to its AES3 output signal. It provides controls for rise and fall time, signal level, sample frequency, jitter level, and perhaps cable simulation. By adding known amounts of degradation, you can determine when a device will begin to have difficulty decoding the datastream and where it will eventually lose lock.

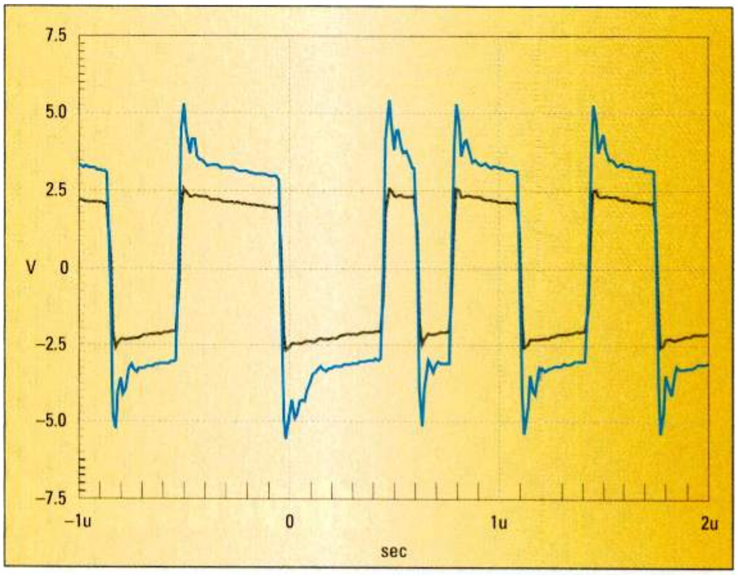

Figure 4. This diagram shows an AES3 datastream with proper source, cable and termination impedances (black) and without (blue).

Additional measurements

We have talked about the integrity of the datastream itself — but what about traditional audio measurements? What errors do converters introduce? How can you characterize a cross-domain device? Again, a sophisticated dual-domain audio-measurement system can give you insight into the real audio performance of such devices.

To characterize a digital-to-analog device, such as you might find in a system that plays back a signal stored on a hard drive, you have to generate an AES3 digital test signal with an embedded audio signal. Generating such a signal completely in the digital domain can give it a dynamic range and residual distortion better than 140dB, far exceeding the performance of any converter and the best analog circuits. Measuring the resulting analog audio signal with a high-performance analog analyzer allows accurate characterization of the DAC.

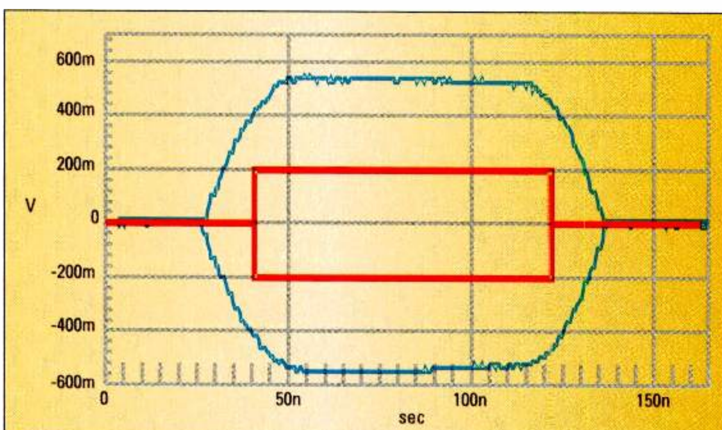

Figure 5. The blue pattern in this diagram is a typical eye pattern. The red box shows an AES3 jitter limit.

For a more comprehensive analysis, add calibrated amounts of data impairments on the digital side and see the effect on the analog audio. Of course, the reverse is also true: characterize a recording device and its ADC by generating high-performance analog test signals and analyze them in the digital domain with an instrument capable of making such measurements. Some converter-specific measurements would include frequency response, with particular attention to the upper-band edge to characterize the anti-aliasing and reconstruction filters. Low-level linearity measurements, noise modulation, quantization distortion and truncation artifacts can help you evaluate the analog-to-digital conversion circuitry of a device. All of the graphs and test results shown in this article were produced with an Audio Precision ATS-2 audio-measurement system.

Summary

Digital audio signal transmission and storage offers the advantage of higher initial quality, more robust delivery, virtually no progressive degradation with successive generations of storage or transmission, and more predictable quality at the far end. But these advantages can only be realized if the AES3 digital data transmitters and receivers in the individual devices in the chain are well-designed and if the transmission techniques follow good digital-data practices. Knowledge of the mechanisms of degradations and how they play out with the equipment in your facility will prevent unpleasant surprises and ensure high-quality audio delivery.

For more information on the subject of digital audio, including in-depth discussions on real-world problems, see the book *Measurement Techniques for Digital Audio* by Julian Dunn. This book is available from the Audio Precision Web site at: audioprecision.com/publications/apnotes/index.htm. BE

Wayne Jones is vice president of applications support at Audio Precision.

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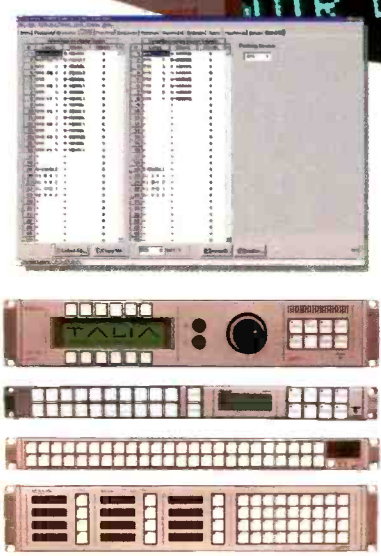

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Video file sharing

BY MOHAN G. MYSORE, GERRY JOHNSEN AND JOHN HEARN

In today's competitive environment, broadcasters are under pressure to increase production quality while reducing costs. One way to help achieve these goals is to deploy affordable digital video-editing workstations. When deploying one workstation, a broadcaster's main concern is maximizing the workstation's capabilities. But, when deploying a number of such workstations, the broadcaster's concern shifts to facilitating collaborations among them — sharing video files.

The video-processing workflow includes many steps that access and transform video files, and each step may occur in multiple sequences and iterations. Given the amount of content access and the number of workstations that can be involved, the file-sharing method that a facility implements can have a major impact on its productivity.

The file-sharing method that a facility implements can have a major impact on its productivity.

Distributed vs. shared storage

A distributed-storage architecture stores video files on local devices directly attached to each of the workstations.

Operators transfer files between workstations through Ethernet-based LANs or by using removable media. While distributed storage can be successful for small implementations, problems grow exponentially with the number of users and workstations. For this reason, many organizations are turning to shared-storage architectures. The two leading shared-storage architectures are storage-area networks (SAN) and network-attached storage (NAS).

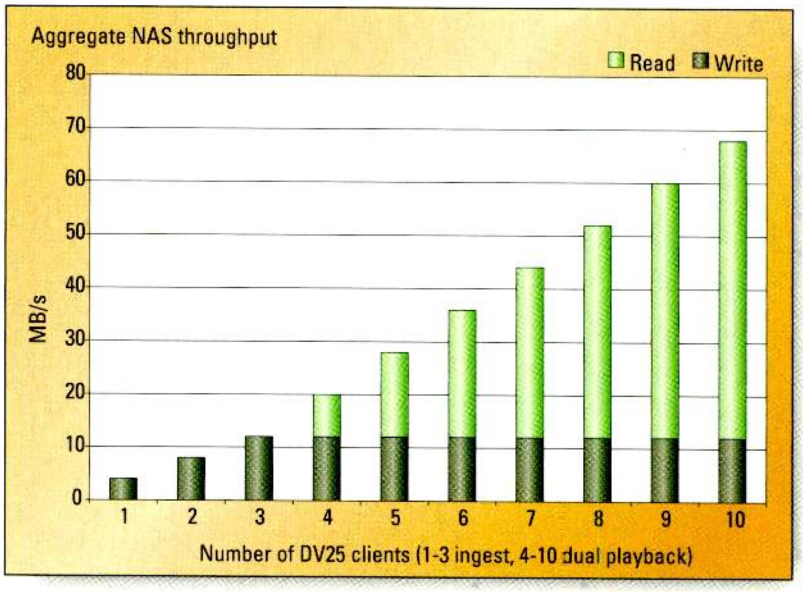


Figure 1. This graph shows the results of aggregate NAS throughput tests achieved without dropped frames.

SAN solutions

Given the high data-throughput requirements of centralized video-file sharing, it's not surprising that many facilities have rapidly adopted SAN solutions. Fibre Channel's highly efficient data transport can provide near-wire-speed performance with minimal CPU use. SANs also provide facility owners the flexibility to scale storage capacity and, more importantly, to scale performance and number of users.

A basic SAN for video editing among multiple workstations centers around a Fibre Channel fabric, which provides the physical data-transport layer connecting redundant storage. A thin software layer residing on each workstation manages centralized file sharing. The software redirects access requests through a specialized server that acts as the file-system lock manager, ensuring that users maintain the proper concurrent access rights.

Storage virtualization can distribute data across multiple devices, increasing system performance without increasing the management burden. Large-scale production and broadcast systems typically include additional workstations to manage content archive, asset management and other additional functions.

NAS solutions

NAS file-sharing solutions, which provide centralized file-sharing services similar to SAN, offer a lower total cost of ownership (TCO) compared to a SAN solution because they have the following characteristics:

- Ease of integration — minimal client impact, no client-side file software, no Fibre Channel, fast install, better application compatibility
- Lower maintenance costs — product monitor alerts, call home function, on-the-fly expansion, SNMP, integrated NDMP backup
- Lower acquisition cost — Gigabit Ethernet component costs vs. equivalent Fibre components.

Dispelling NAS myths

Myth #1: Poor transport efficiency

While it's true that Gigabit Ethernet requires more processing power than Fibre Channel to move an equivalent amount of data, this does not preclude Gigabit Ethernet from being an appropriate transport for video applications. High-performance NAS devices can provide enough bandwidth through a single connection to support five to 10 workstations simultaneously processing DV25 and higher-data-rate video formats. For example, Ciprico has tested its DiMeda 2400 Digital Media Appliance across multiple clients

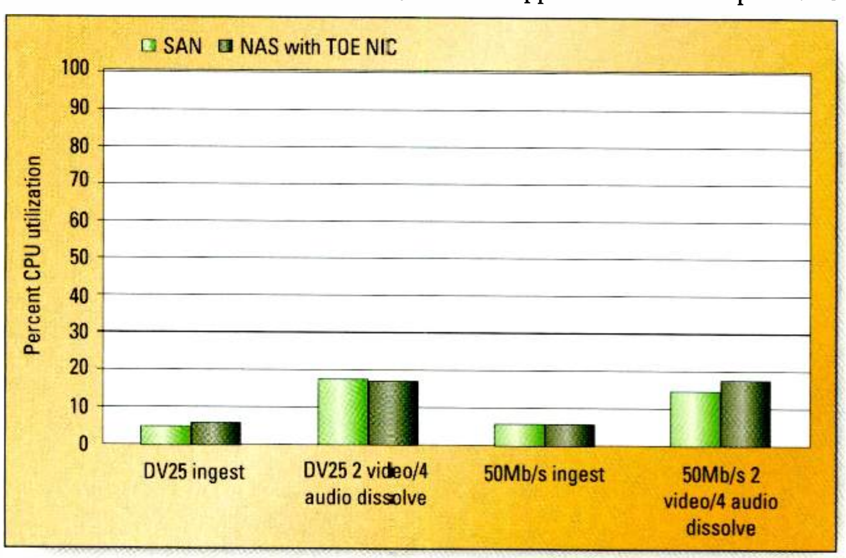
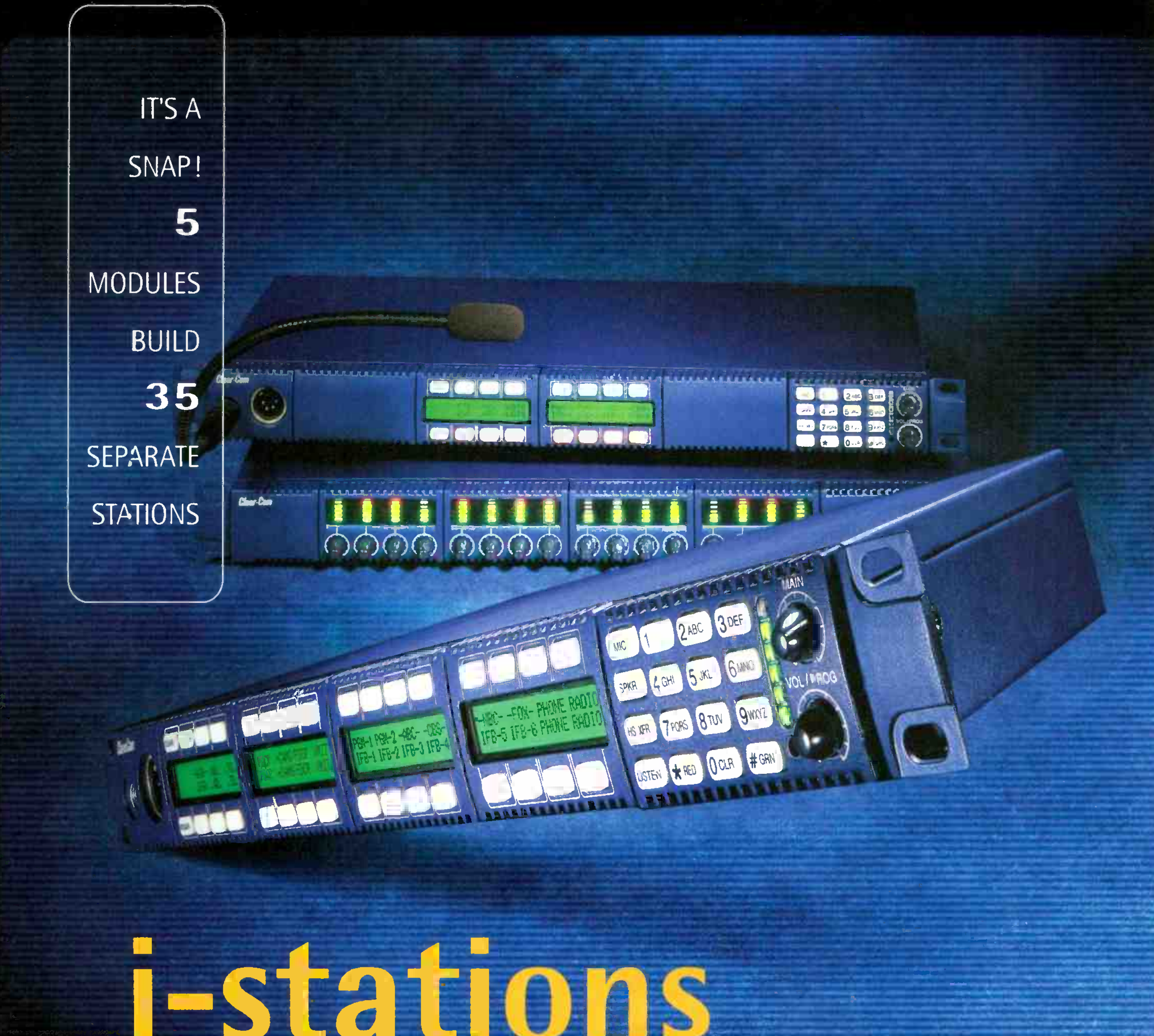


Figure 2. This graph shows the net client-side CPU use during DV25 and 50Mb/s video ingest and dual-channel playback for SAN and NAS configurations.


IT'S A SNAP! 5 MODULES BUILD 35 SEPARATE STATIONS
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using Matrox hardware with Adobe Premier and Windows Media Player software to simulate worst-case throughput loading. Figure 1 shows the results of these tests achieved without dropped frames.

Client-side CPU use is also an important consideration. The application software must not become resource-starved as transport rates increase. Figure 2 shows the net client-side CPU use during DV25 and 50Mb/s video ingest and dual-channel playback for SAN and NAS configurations. By using a hardware-accelerated Gigabit Ethernet network-access card in the client, CPU use levels for SAN and NAS configurations are virtually equivalent.

Myth #2: Unreliable quality of service

Much debate has ensued over the non-deterministic nature of Ethernet LAN flow control based upon carrier sense/collision detection vs. Fibre Channel buffer credit system. The truth is that a properly designed Gigabit Ethernet network can provide the performance required for multiple video file accesses for video formats up to and including DV50.

The critical point is determining the right balance between quality of service and TCO. The range of performance may be the determining factor in SAN vs. NAS. For upper-end applications, SAN offers users storage and performance scalability. For the majority of applications found in broadcast nonlinear editing, NAS is more appropriate and easier to implement.

NAS-based storage relies on existing, well-defined network-security standards.

Myth #3: Unsecured

The mere mention of the words "Internet Protocol" can conjure images of hackers siphoning valuable content assets. Fibre Channel-based SANs address this threat through the inherent physical security of a separate network. Limiting access to the SAN network controls outside threats, but provides very little security within the network. NAS-based storage relies on existing, well-defined network-security standards. In fact, most SAN-attached storage is accessible through the attached servers and therefore is protected by the same mechanisms as NAS.

The best of both worlds

Storage systems have traditionally provided best-effort bulk storage of content. Applications like video, which require a specific quality of service, have generally been supported by expensive solutions that impose a significant burden on IT budget and staff. A modern storage system must meet application requirements such as I/O and bandwidth, yet must also provide services in an economic manner with minimal administrative involvement.

An appliance that provides the performance of SANs, the ease-of-use of NAS, and a set of services designed to integrate digital production and broadcast functions can improve productivity, lower the cost of production, and generate new lines of revenue. **BE**

Mohan G. Mysore is market manager for entertainment and media, Gerry Johnsen is senior product manager, and John Hearn is senior product architect for Ciprico.

Sony's new production switcher series

BY STEVE WYNN

As the television industry moves into the DTV environment, the content sources feeding a modern TV production chain are presenting unprecedented challenges in program creation. In the live event category, the production switcher is a central element and must be capable of handling and optimizing new types of input signal formats. It must also be capable of delivering new types of output formats, differing in resolution, aspect ratio, frame rate and scanning type. The new Production Engine technologies from Sony evidence next-generation video processing technologies and architecture applied to current and emerging DTV requirements.

The simple, basic nature of the production switcher task has changed dramatically and grown more complex. The production switcher must now operate in a world experiencing new digital television distribution formats and a growing acceptance of digital cinematography (24p, for example). In addition, audiences are increasingly comfortable with the improved resolution and widescreen nature of video images through DVDs.

To accommodate and address these new picture styles, modern production switchers need the flexibility to adapt to any production format requirement. These requirements may vary in aspect ratio, native resolution and even frame rate, options never before involved in program planning. In years past, the mastering format requirements (D2 or Digital Betacam, for example) could be accommodated by virtue of a switcher's serial digital flexibility. This allowed for a project-by-project deliverable format decision. The switcher could be changed from composite digital to component digital operation in short order. In the brave new world of DTV, this type of flexibility becomes a critical feature to support a long life cycle for the production switcher investment.

An example of this flexibility is found in Sony's new series of production switchers, which is designed throughout for wideband signal handling. Physical connection points on the MVS-8000, for example, allow change between 1.5Gb/s high-definition (HD) serial digital streams and 270Mb/s standard-definition (SD) serial digital streams at boot time as required. Coupled with the ability to reboot the system into different frame rates (24-, 50- and 60Hz) and resolutions, this approach presents a practical and economical response to these multiformat production challenges. Beyond the basic idea of multiformat signal handling, the switcher environment allows unique simultaneous, parallel handling of SD and HD signals that are realized through advanced operator interfaces.

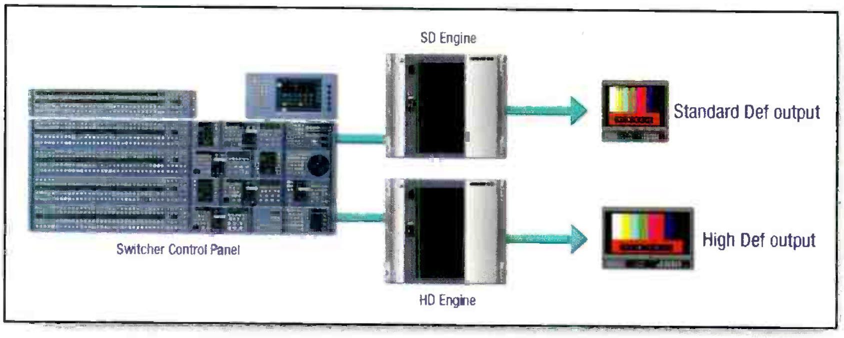

Figure 1. Switchers capable of parallel SD and HD operation enable broadcasters to optimize picture format for both audiences.

> The production switcher must now operate in a world experiencing new digital television distribution formats.

Migration and evolution

The money invested in a production switcher must be validated by evidence of:

- scalability for growth,
- resource-sharing characteristics (to allow the capital equipment to be utilized for more hours in the day and by multiple departments or productions), and
- an optimized price/performance metric.

At a simple level, customers may be looking down the road at eventual HD

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operation, while implementing more immediate transitions such as an initial buildout to digital in SD. Contemporary DTV production means, in a very practical sense, that remote trucks may need to respond to a 4:3 SD requirement one day, widescreen 16:9 SD another day, a 1080i or 1080/24p HD entertainment event on yet another day, and perhaps a 720p HD sports event as well.

Over the last few years, many different approaches and experiments in HD event production have been tried. As the HD deliverable becomes more important, the drive to arrive at a practical production process has come to the forefront in the plans of many. Clearly, the cost and complexity of rolling both an SD truck and an HD truck to cover an event is not practical, or desirable, in the long run. One approach, a single production/dual-output approach, is now both workable and practical by combining the advanced technologies shared in switchers such as the MVS-8000 and its SD-only partner DVS-9000 (see Figure 1).

The capability of parallel SD and HD operation allows for creative decisions about picture format to be optimized for both audiences. The parallel picture results can be optimized through correct and natural placement of key elements (game clocks, lower thirds, etc.), versatile framing options, and other flexibility. Key to this workflow enhancement, however, is a capable switcher infrastructure that can implement this style of operation with minimal distraction to the operator.

In the MVS production switcher family, the standard control panel structure is extended with the ability to control two processing engines simultaneously. In this way, hardware power can be applied to optimize each output stream, still driven by the natural, intuitive work style of the production team.

In addition to basic intra-component control, the switcher has implemented an additional data network for direct data exchange and handling (the data LAN). This network allows communication with and between control panels, processors and peripherals to allow such things as image file transfer, setup files and software upgrades, as well as maintenance and facility management tasks.

The characteristics of the production switcher fundamentally shape the programs produced. As multiformat productions become the norm, and more sophisticated production elements are required, the choice of production hardware will remain a key element. A multiformat picture processor, along with creative application of data networking techniques, as evidenced in components such as the Sony MVS-8000 production switcher, provide a practical response to evolving, real-world work styles and emerging digital challenges. **BE**

Steve Wynn is director of technology marketing for the broadcast and professional systems division of Sony Electronics.

APVI manages data with Avalon

BY TONY BESWICK

That digital technology has empowered radically new ways to create and distribute media is not a revelation. The ability to digitize video content has made APVI look hard at issues like supply chain management, process control, workflow efficiency, time-to-market and global collaboration.

New Jersey-based Audio Plus Video International (APVI) handles standards conversion, duplication, post production and mastering. We have worked to position ourselves as an end-to-end solutions provider to help our customers repurpose their content to meet the demands of multiple distribution channels and global standards.

We set out to build a data management system that would leverage what has been learned in global commerce about process management, supply chain and multi-site collaboration and distribution. In doing so, we hoped to capitalize on our own experiences in content and broadcast, as well as the partnerships we have with industry vendors.

The lessons of global commerce can also be applied to the stock film industry. Time-to-market is mission critical in the stock film business. Simply put, first in wins the bid. Those who embraced digital distribution early on have achieved industry leadership, while those who failed to come onboard have suffered accordingly.

In broadcast, the ability to seamlessly and efficiently manage the flow of content files between the on-air, archive, automation and online systems has facilitated a supercharged workflow that delivers ROI on the infrastructure. Networking and improved data management have given clients the ability to mine product across a much broader base.

We have taken the stock-footage model and migrated that over to broadcast. With one client, we encode all of the content and then use AVALONidm to manage that content onto DVD. With one of the major sports leagues we use the management software to seamlessly manage EMC Clarion storage systems and Sony Petasites on the back end. We're also porting this technology out to independent producers to enable them to create a metadata content stream and preview low-res or high-res proxy footage.

The goal was to be able to plug anything into the network, whether to add functionality or to add capacity.

Avalon's data management software uses intelligent algorithms to manage data within the storage subsystem according to user-defined policy categories. It contains storage managers optimized for managing files on magnetic disk, data tape and DVD. All three manage data transfers between the storage devices and video servers and other data servers and operate under the direction of the Avalon data manager.

We chose these data management systems because of our goal to remain as manufacturer-agnostic as possible. The front end can be whatever our client wishes, while back-end storage can be anything from a Sony Petasite to an Asaca DVD jukebox to an Ampex DST streamer. Only the core infrastructure isn't agnostic. The system's ability to control other product bases impressed us.

Our open approach required a universally scalable architecture. The goal was to be able to plug anything into the network, whether to add functionality or to add capacity. All of the technologies would also need to pass a threshold for robustness and security.

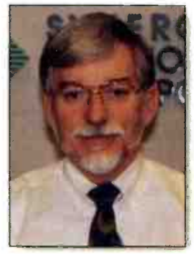
Over the past five years, the manipulation of content has evolved from traditional analog and digital videotape to storage media and disk- and tape-based file transfers. The continued development of more advanced infrastructures and storage management systems will be equally progressive.

Over the next five years, there will continue to be tremendous change as the model transitions to the delivery of files over ATM or other proprietary fiber backbone. We've worked hard to build the creative hubs and to streamline efficiency within the hubs and now we're concentrating on the bandwidth bottleneck and improving the speeds at which we can communicate with our customers and partners. We're a standard-definition application and we're seeing more customers looking for satellite- or fiber-delivered digital files. APVI is positioning itself to meet this need. BE

Tony Beswick is the vice president and managing director of Audio Plus Video International.

Production switchers

BY JOHN LUFF



Movies usually portray the glamour of television with a shot of a large control room (usually at a New York network studio) with a passel of production people sweating over a newscast or awards show. A shot of the production switcher always makes the final cut because it epitomizes the glitzy, high-tech look the audience associates with television production. In fact, a close-up shot of a Grass Valley Group Model 100 production switcher actually appeared in one movie as the controls of a nuclear power plant.

Most live broadcasts involving more than a camera or two must use some kind of production switcher. Whether the studio is a location production truck that can accommodate only two people or a control room with 20 chairs in it, the production switcher is an essential element. A switcher has a number of inputs ranging from four to 80, which can be combined into a number of outputs, ranging from one to 50 or so. In a digital mixer, the software that mixes the inputs allows the usual range of cuts, wipes, dissolves, keys, effects, moves and fades in at least one, and as many as four, complex mix-effects banks. (This article focuses on digital switchers because few analog production switchers are sold new today.)

Those who want to upgrade to digital switching without replacing their old analog control panel may benefit from a solution like the Ross Video frame shown above.

A brief history

The first analog production switcher was a GVG device that predated 1966. At that time, Ampex, CDL, GVG. RCA and Vital all sold switchers. Today, GVG has been reborn for the third time, and the rest have disappeared, replaced by Echolab, Ikegami, Panasonic, Parkervision, Pinnacle, Ross, Thomson Grass Valley, Snell & Wilcox, Sony, Videotek and others. The number of models of switchers available from these companies and the range of options they offer is mind-blowing, producing results no one dreamed of in the mid-70s when Vital brought out the Sqeezoom (along with the highly valuable and still-available heart wipe).

With the introduction of digital switching based on software, the days of manual switcher setups have passed. (You might remember the literally hundreds of interacting pots in an Ampex AVC-4100 switcher. It was quite an art tweaking one up to high standards.) The capability of every basic switcher today is light years ahead of the most sophisticated switchers made a decade ago. Take the venerable GVG Model 100 as a base point and you will find many similar-looking digital switchers today. Compared to the original, each of these modern Model 100 look-alikes provides more functionality, the same or better reliability, and superior performance. And, in deflated dollars, they even cost less.

The number of models of switchers available and the range of options they offer is mind-blowing.

Decisions, decisions

But all these choices present a problem: How do you select the switcher that's right for you? A good way to begin is by looking for the number of inputs you feel you need. Be sure to count key signals because most modern switchers don't segregate key inputs from primary video inputs. There are switchers as small as four inputs (for ENG applications), and as large as 80 inputs (available from Sony and Thomson Grass Valley). Effects systems range from simple key and dissolve effects in some ENG products to a full range of mix, wipe, key and DVE effects in one to four mix-effects (M/E) configurations.

If your facility has several control rooms, large and small, you should consider systems that allow you to standardize an operator interface (control panel design). This will allow your personnel to move easily from one room to another without retraining. Thomson Grass Valley offers the Zodiak and Kalypso series, and Sony has the MVS-8000/DVS-9000 series based on similar technology. Ross Video (Synergy one to four) and others provide a similar range of scalable products.

At one time, digital video effects were defined by a statement like, "What kind of ADO do you have?" Well, ADO is gone. But in its place is a range of digital effects systems integrated into the production switcher, and this trend has really caught fire. Not long ago, a four-channel DVE was considered huge. Pinnacle Systems' PDS 9000 has nine

DVEs, Thomson Grass Valley has six dual video/video or video/key channels, and Ross has eight channels.

Still stores have also become a necessity in switchers. Some have capacities that make separate still stores unnecessary in many applications, with storage for literally thousands of uncompressed frames. This is a blessing for the budget, but a curse for the TD who has to operate it. Fortunately, some manufacturers provide a separate control panel that offers limited functionality for a second operator. If you have lot of stills and change them often, consider an outboard still store in addition to the very useful internal units.

GVG invented effects memory with EMEM a long time ago. Since then, every manufacturer has been able to come up with its own similar system while avoiding the patent attorneys. With a complex switcher, pay particular attention to how those setups are stored and recalled, and stored offline as well. Floppies are convenient, but a zip disk might allow you to off-load stills and save them with the rest of the setup for a program. In the sports-production business, many clients bring the setup for their entire show in on removable media so that the TD does not have to reprogram each effect in each truck.

Not long ago, a four-channel DVE was considered huge.

HD and beyond

Technology does matter, and the evolution of technology leaves old products in the dust altogether too often. HD production switchers have been available for many years. Full-featured units have been available from Sony, Snell & Wilcox, Philips (Thomson Grass Valley) and others since the late '90s. A new crop of switchers that can handle a full range of standard definition and multistandard HDTV is now on the market. They provide the ability to use a studio to produce an HD program now and switch back to SD production at will. This may well be a key to getting wide acceptance for the cost of HDTV-capable systems.

Lastly, it would be unfair not to mention that Parkervision has innovated production with a system that includes a video switcher. The switcher can be timeline-driven using a technical script that includes not only the production-switcher events, but also the character-generator pages, script and teleprompter, and audio console. The era of automated news is here and, for many stations, the appeal of lower labor costs is irresistible. **BE**

John Luff is senior vice president of business development at AZCAR. To reach him, visit www.azcar.com.

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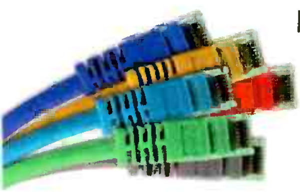

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Martinsound Flying Faders II: main screen has been reworked to provide a multi-tabbed graphic interface; offers one-click access to any setting; new features include control and automation of multiple computers and multiple platforms, and complete integration with DAW markers and regions, as well as the ability to save and recall the entire mix tree, and local event control from the fader panel.
800-582-3555; www.martinsound.com

MASTERING VTR

Panasonic AJ-HD3700: industry-standard D-5 HD multiformat/multi-standard mastering VTR; enhanced with new capabilities that make it a true universal, international mastering recorder; can record and playback both 625 PAL and 525 NTSC D-5 cassettes, as well as D-5 tapes from all previous versions.
800-528-8601; www.panasonic.com/hdworld

DISPLAY PROCESSOR WITH WIDE-SCREEN MODE

RGB Spectrum 4View 100: displays four video inputs on a monitor, flat panel or projection screen; displays all four signals at full resolution on a 1280x1024 pixel screen, providing higher video quality and superior viewing experience; new wide-screen mode has one large window plus three stacked smaller windows on the side to utilize the available display real estate.
510-814-7000; www.rgb.com

WIRELESS SYSTEMS

Audio-Technica 5000 and 4000 Artist Elite: both systems come in multiple configurations, including handheld and UniPak transmitters; multiple receivers of both series can be linked and both feature IntelliScan frequency selection and dual compansion; the 5000 series includes PC- and Mac-compatible control software.
330-686-2600; www.audio-technica.com

NONLINEAR EDITING SYSTEM

Leitch dpsVelocityQ: combines multistream real-time hardware and enhanced NLE software into a fully integrated solution for creating content for video, broadcast, CD-ROM, DVD and the Internet; powered by dpsQuattrus hardware; features real-time simultaneous playback of four video streams in any combination of uncompressed or compressed video, and six dynamic graphics streams.
416-445-9640; www.leitch.com

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DIGITAL PRODUCTION SWITCHER OPTIONS

Ross Video Squeeze & Tease 3-D and Ultimatte Insider: these options have been added to the Synergy 100 digital production switcher; Squeeze & Tease 3-D option provides two channels of 3-D DVE effects to the Synergy 100 enabling transitions, over-the-shoulder boxes, and the ability to fly and transition any type of key; Ultimatte Insider provides advanced keying in super critical applications.

613-652-4886; www.rossvideo.com

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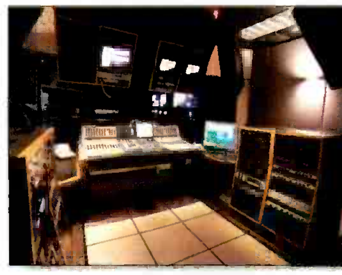


Artbeats Digital Film Library: contains over 125 titles, including 18 high-definition clips; film/video source material is digitally scanned; dust, scratches and flaws are removed; and footage is color-corrected; content can be delivered on CD or accessed via the Web; all standard-definition stock footage products are licensed royalty free for all uses and delivered in QuickTime format in NTSC and PAL.

DEMO ROOM

800-444-9392; www.artbeats.com

VIDEO COAXIAL CABLE

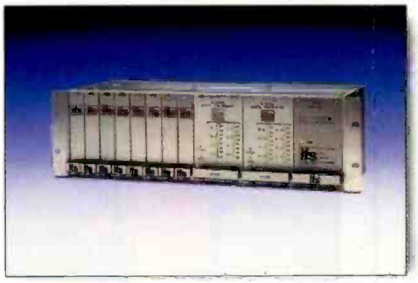
Belden Brilliance NEC-rated 1505F: exceptionally flexible version of Belden's 1505A RG-59 digital video coax cable; combats installation-related stresses such as repeated pulling, flexing, bending and crushing; ideal for use in patch bays, mobile studio trucks, remote outdoor field locations and studio settings.

800-BELDEN-4; www.belden.com

FILTER

Andrew DTV Triple-Mode Filter: for use in medium-power digital television broadcast systems; low insertion loss filter (7.5kW reflective type or 15kW constant impedance type) is suitable for medium-power DTV transmitters; compact size; tunable for a variety of frequency responses to meet broadcaster requirements; all-aluminum construction.

708-349-3300; www.andrew.com



VIDEO MULTIPLEXING EQUIPMENT

IFS VT/VR71630: offers true real-time eight-bit digital video performance; transmits video signals that exceed the RS-250C medium-haul performance specification; transmits up to 16 real-time video channels with a consistent signal-to-noise ratio up to the maximum optical path loss of the system.

203-426-1180; www.ifs.com

DOWNCONVERTER

Miranda Technologies QDC-801i: 10-bit HD downconverter that conforms to SMPTE 292M and outputs to SMPTE 259M-C for SDI, SMPTE 170M for NTSC, and ITU 624-4 for PAL; both automatic line format and frame-rate input, as well as VLI and WSS information insertion, are provided; offers advanced 3-D de-interlacing with edge detection and interpolation and 3:2 pull-down detection.

800-224-7882; www.miranda.com

VIDEO STREAMING SERVER

Optibase MGW 2400: Microsoft Windows Media compatible streaming server allows ISPs to offer broadband services over digital subscriber lines (DSL) and cable modems to residential and enterprise markets; system does not require end users to download or install a special player application.

800-451-5101; www.optibase.com

FIBER TRANSMISSION MODULES

Optelecom 9815T transmitter, 9815R receiver and 9815TR transceiver: accept serial digital data conforming to SMPTE 259M, 294M and 305M standards at data rates up to 360Mb/s; versions are available for multimode fiber with transmission ranges up to 4Km, and single-mode versions with transmission ranges to 71Km; 9815T transmitter and 9815R receiver utilize one fiber, while the 9815TR transceiver uses two fibers.

301-840-2121; www.optelecom.com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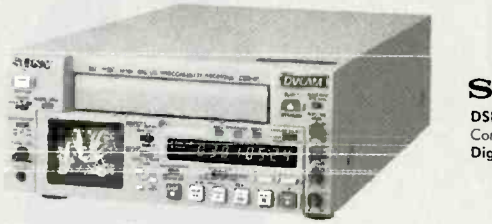

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KOMU-TV, an NBC affiliate located in Columbia, Missouri, is currently seeking a Chief Engineer with a minimum of 6 years working in television broadcast engineering. Applicant must have a bachelor degree in electrical engineering or a combination of equivalent education and experience. Applicant should also have experience in broadcast engineering management including budgeting, project management, employee supervision and evaluation, as well as solid working knowledge of FCC regulations. Troubleshooting electronics down to the component level, equipment design, integration, and installation are also required. VHF NTSC and UHF ATSC transmitter experience is also required. Experience with computers in both hardware and operating systems is desirable. This position will require working in a team environment setting goals, developing projects and strict timelines to further the mission of the station. KOMU-TV is a commercial television station licensed by the Curators of the University of Missouri. To apply, send resume, indicating Vacancy #SC69651 to: Sheryl Cullina, University of Missouri-Columbia, Human Resource Services (MU), 130 Heinkel Building, 201 South 7th Street, Columbia, MO 65211-1340 (573) 882-7976, FAX: (573) 882-9975 email: umchrs@missouri.edu webpage: http://mujobs.missouri.edu/eeo/aa

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EQUIPMENT RENTAL HOUSE in Atlanta has immediate opening for the position of Engineer. Applicants must have an engineering degree or equivalent experience and a minimum of five years broadcast engineering experience. A solid engineering and broadcast perspective is required with knowledge in system distribution and component level trouble shooting. Please fax resumes to Rose Smith at 404-351-9315 or email us at info@charterabs.com.

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www.broadcastengineering.com

CHIEF ENGINEER. Kgun9 seeks a Chief Engineer, a strong performance based leader with proven technical, organizational, planning, and people skills. The successful candidate must demonstrate the ability to provide the technical expertise required to achieve station strategic goals and objectives. Hands on, proactive approach required. Previous television technical management experience a must. A strong Assistant Chief who feels ready to lead a technical department will also be considered. Send resumes to: Jan Robinson, Executive Assistant, KGUN9, 7280 E. Rosewood St., Tucson, AZ 85710. NO PHONE CALLS PLEASE

RADIO & TELEVISION ENGINEER KSKA/KAKM TV: KSKA/KAKM, Anchorage, AK seeks Engineer to serve as asst. chief engineer. BS, EE, or comparable degree and/or relevant exp. 3-6 yrs. in field including supervisory exp. For more information visit our website at www.livingstonasociates.net or contact Tom Livingston at (703)691-8737

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What's in a name?

BY PAUL MCGOLDRICK

There are actually consultant companies out there who will take a small fortune from you to tell you what you should call your company.

What do Dolby, Gates, Leitch, Moseley and Orban have in common? They were all companies that took their founders' names as the company name. That's not been an unusual thing in the history of incorporation – think Ford, Heinz or Disney – but it doesn't seem very popular today.

In fact the "professionals" out there now say that it is a bad idea to name a business after yourself because you may, among other reasons, end up selling your name with the company down the road. However, Harris, for example, had no problem squashing the Gates name above the front door, while it continued to be used on the products for some time.

Nor, they say, should you indicate in the business name anything about the nature of the business: You may, after all, find out that the things you can make and sell – or provide a service for – are not the ones you were originally thinking about. That's why International Business Machines had to become IBM, they indicate, because of the PC; General Electric had to become GE because of its spacecraft work; Minnesota Mining & Manufacturing had to become 3M… you get the picture. (Incidentally, there is a story that the head of General Electric traveled to England in the early part of the 20th century to talk with executives at The General Electric Corporation based there. Their discussions were to determine if one of the companies should change their name to avoid investor or customer confusion; they decided neither should because business would never be international enough for there to be any problem!)

At the same time there is nothing wrong with the name Amtrak to show very clearly the nature of its business (the inability to succeed in it is another matter). But decisions by a company like Burlington Northern to get into the "transport" business rather than just rail traffic made it drop railroad from its name pretty quickly. Any name may end up dating or pigeonholing you.

People-named companies are often very successful ones: Peter Norton is the one that immediately comes to mind, and I will still remember his name when the "strategic" names have long disappeared; names like Avaya, Accenture, Azanda, Anadigm, Agere, Agilent – and that's only the "A"s. At the other end of the alphabet the combinations using the letter X and Z are unbelievably complex, and you really hate to ask some of these companies how they believe their name should be pronounced.

There are actually consultant companies out there who will take a small fortune from you to tell you what you should call your company. People ask, they say, for company names with fewer than seven letters, but some of the experts are analyzing customer reactions to companies with as many as three words in the name.

Maybe the Internet has caused a lot of this. Are some companies basing their names on their ability to register a domain? I suspect they are. Apparently all the possible three-letter combination domains are gone; but if you go look, some of them are hilarious, others have no relationship whatever with the company's trading name, and still others, like zjx.com, are being held by speculators – in the obvious belief that someone can come up with words with such initials. If they do, it won't be in English!

In our industry there were no bad effects for Parker Gates, James Leitch, Jack Moseley or Bob Orban in the get-ahead game of doing business. Yes, their names stuck with the company at sale – in one way or another – but we continue to think of all of them as reliable and dependable. Surely that has something to do with the feeling that there was a stopping point for the buck in each of those companies, as we still think of Ray Dolby. Have you seen any of the companies involved in last year's scary financial tricks with the founder's name still attached? I believe Morgan-Stanley is it, as even Arthur Andersen had changed its name by that time.

The experts – yes, them again – say that the new owners of the company you have named after yourself could harm your reputation after ownership changes, but that has certainly not happened with any of the above broadcast equipment companies. Nor is it likely to, because we're a technological industry where the inventor's vision went into the products. You would have to work really hard to mess it all up.

We could talk about Martha Stewart Omnimedia. But that's another column. **BE**

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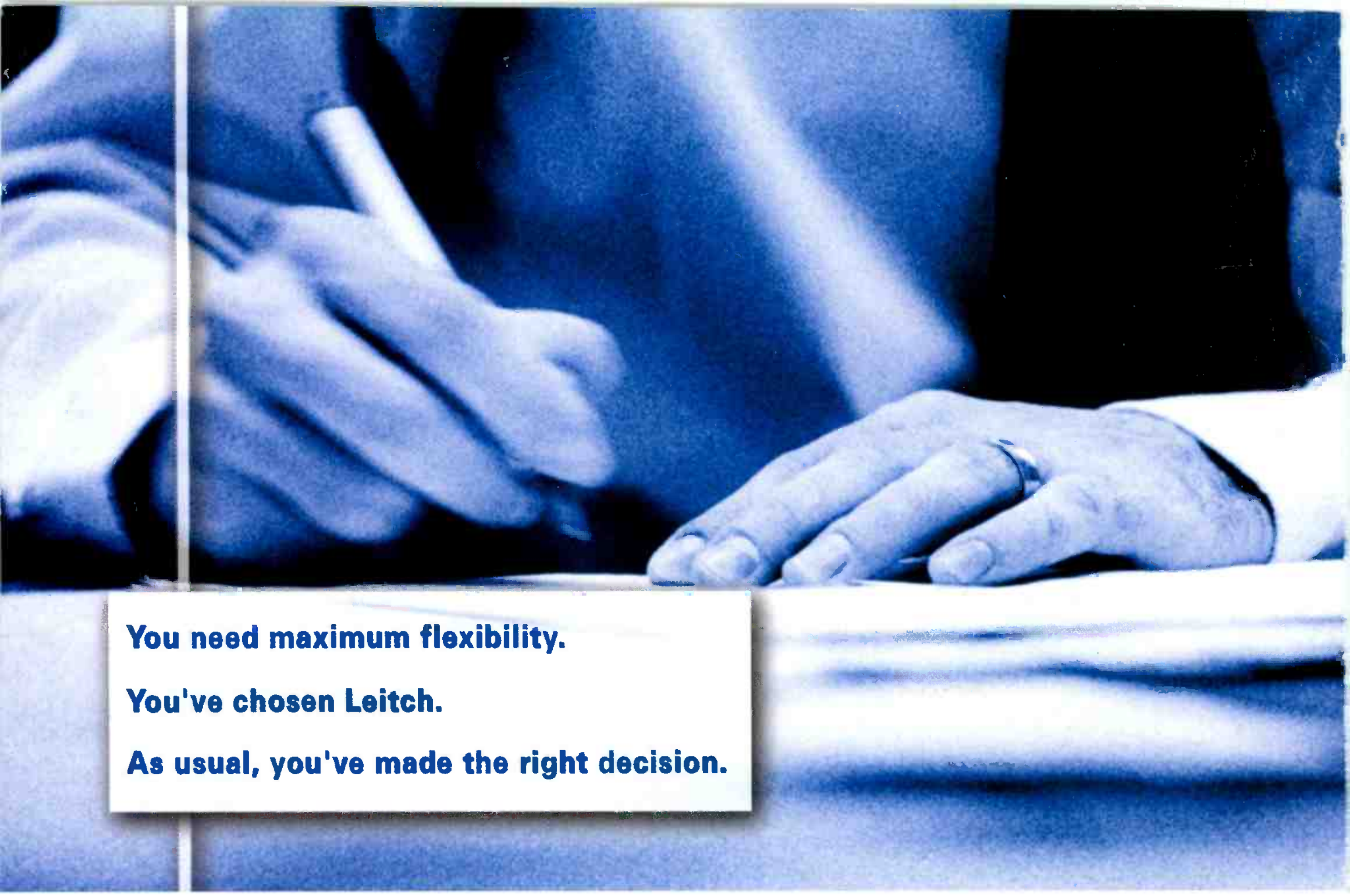

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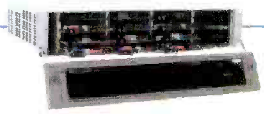

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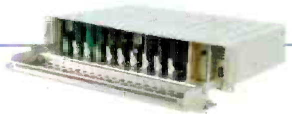

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