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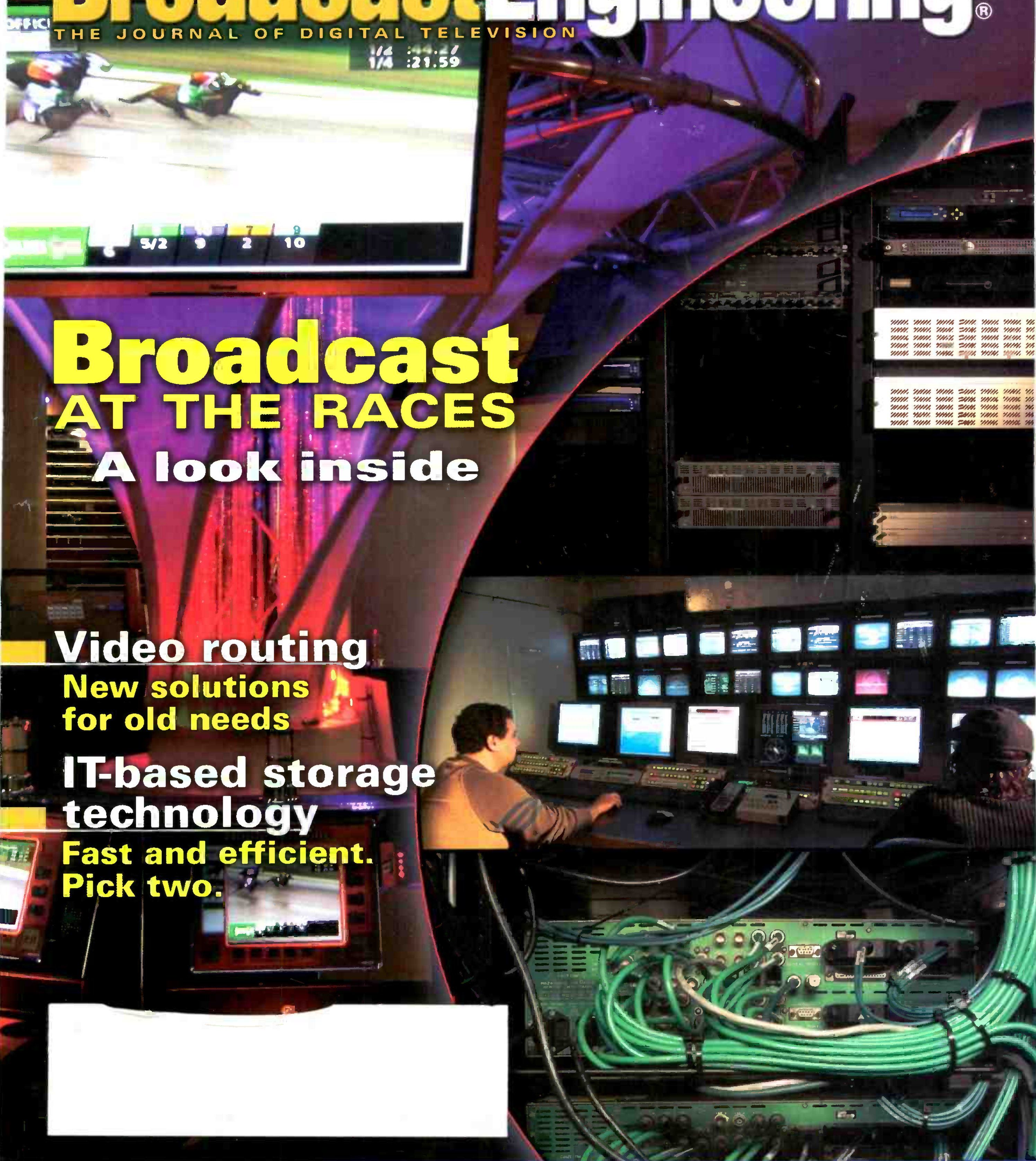

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A look inside

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New solutions for old needs

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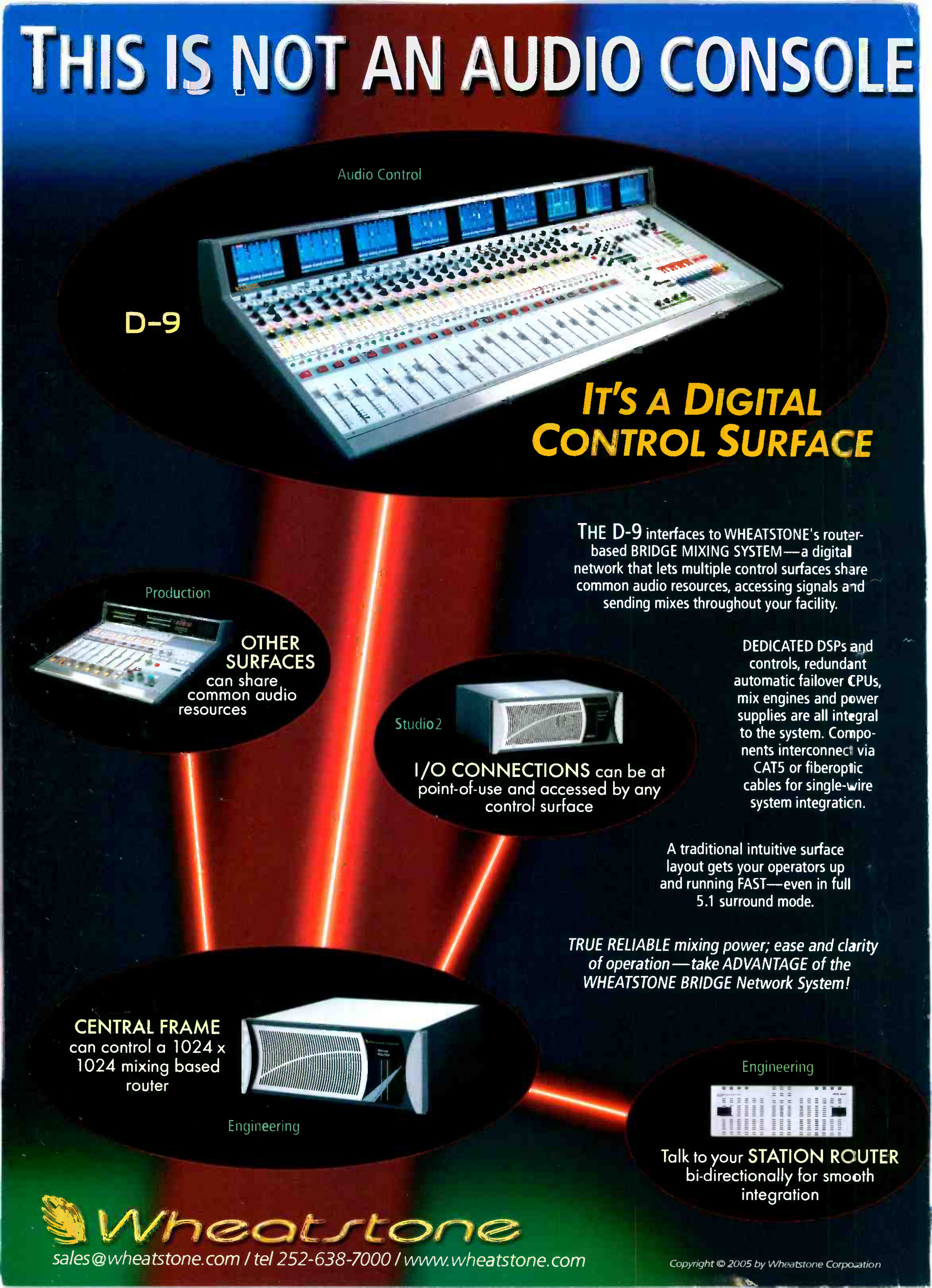

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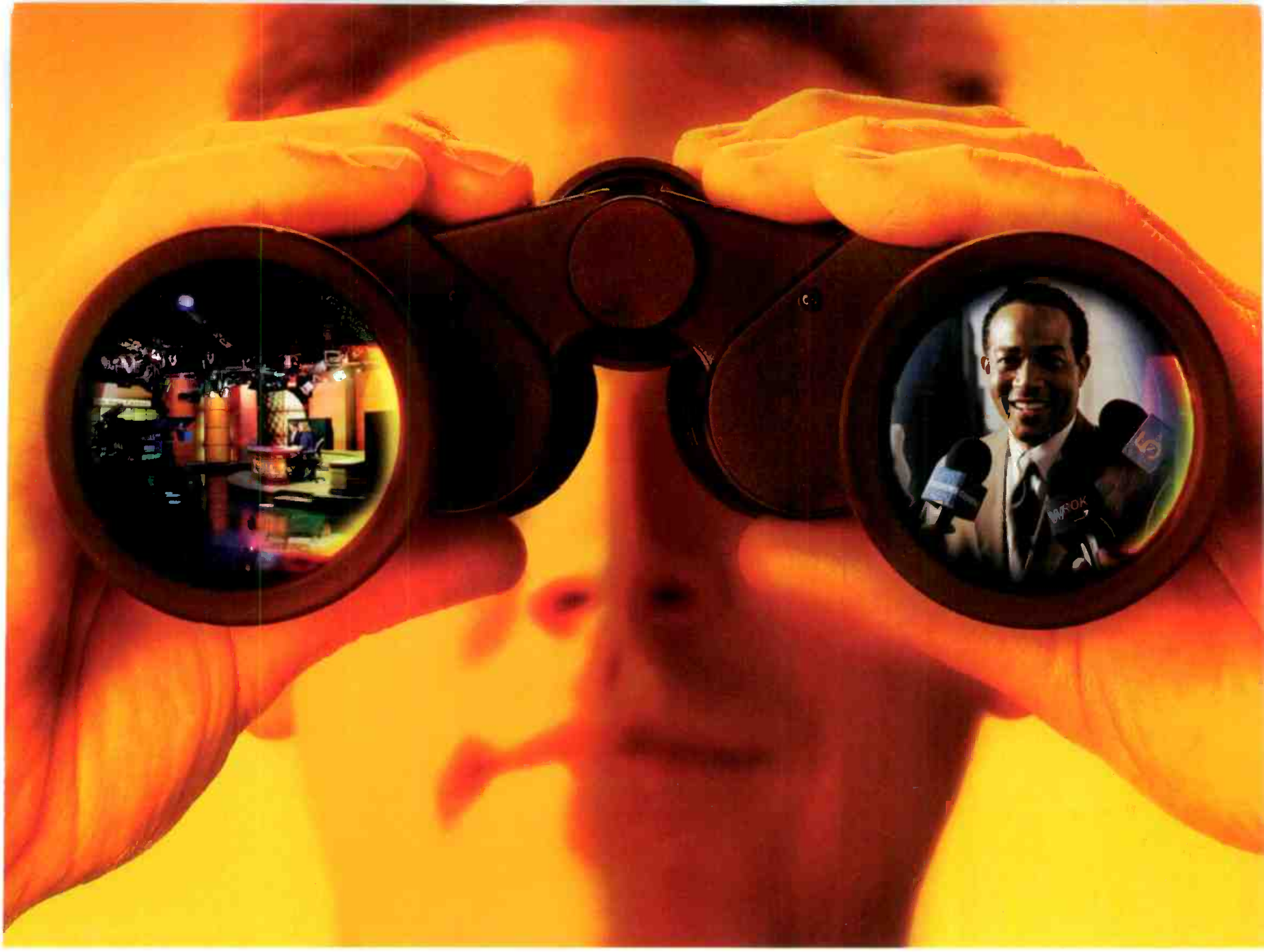

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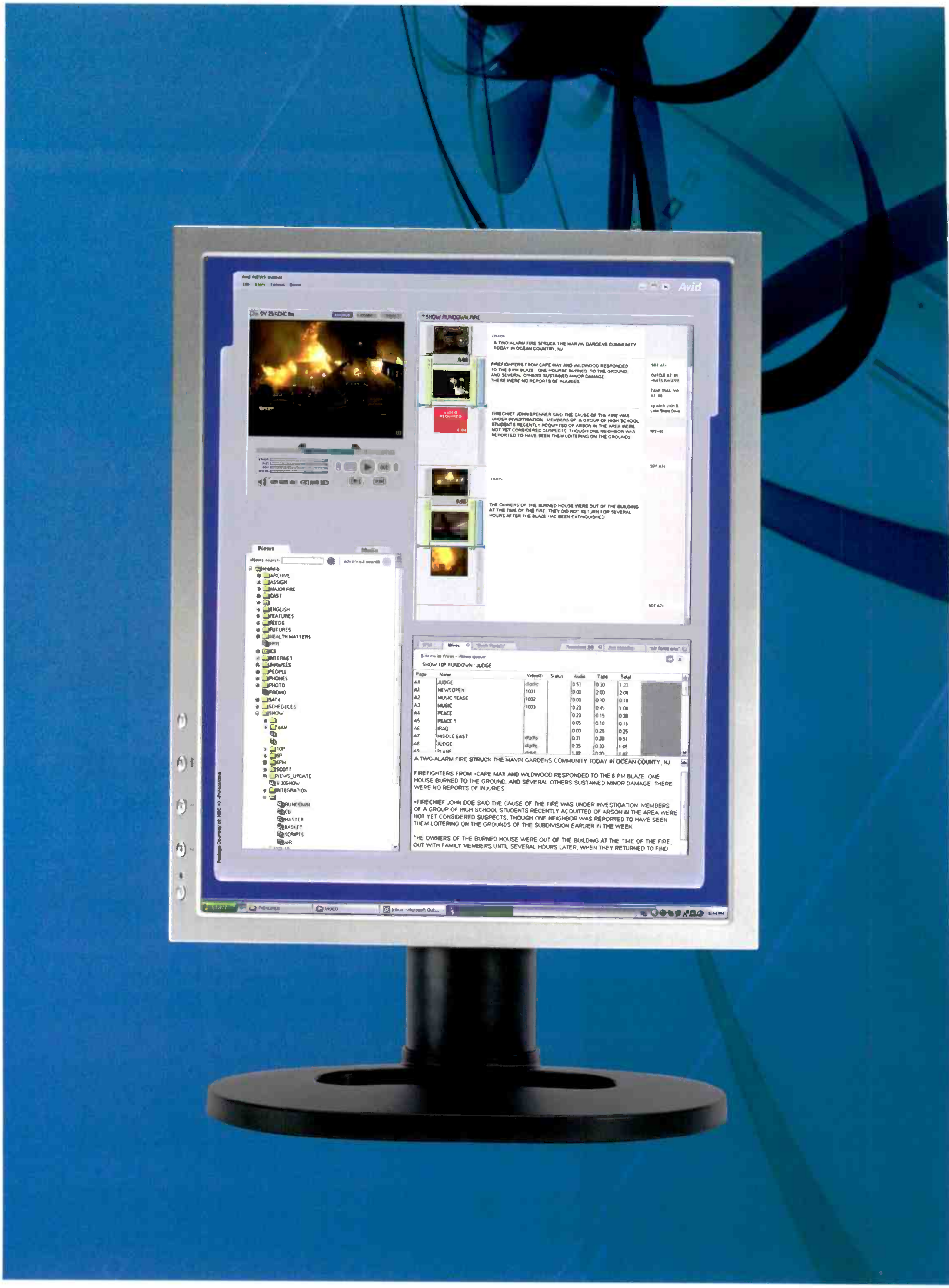

Avid

MAY • VOLUME 47 • NUMBER 5

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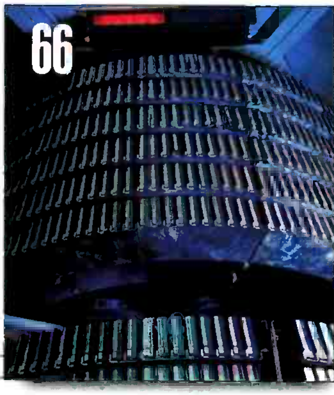

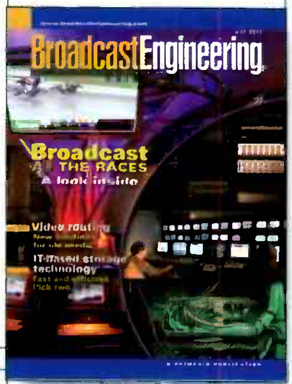

ON THE COVER: Magna Entertainment provides live broadcast feeds to racetracks around the world.

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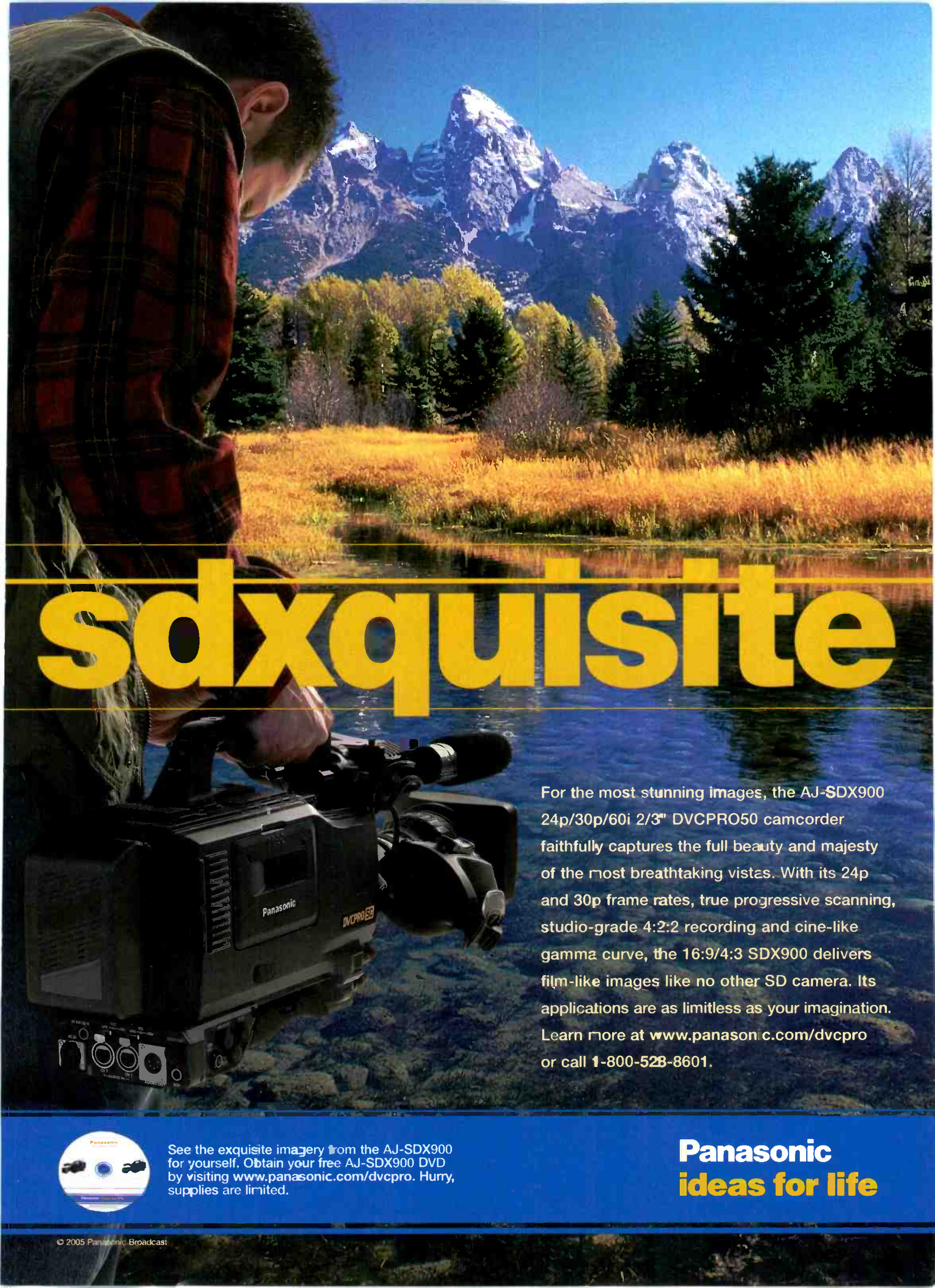
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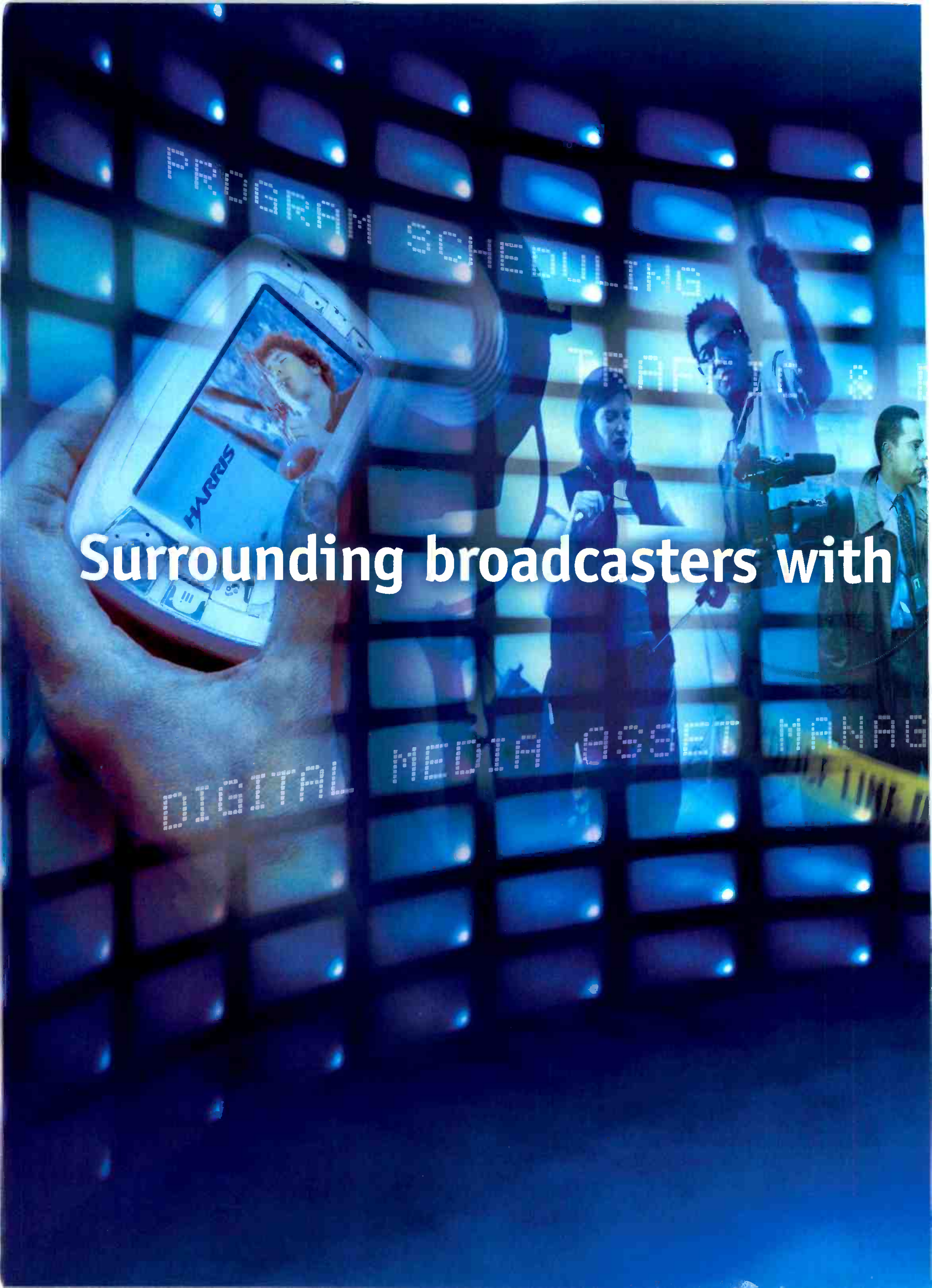
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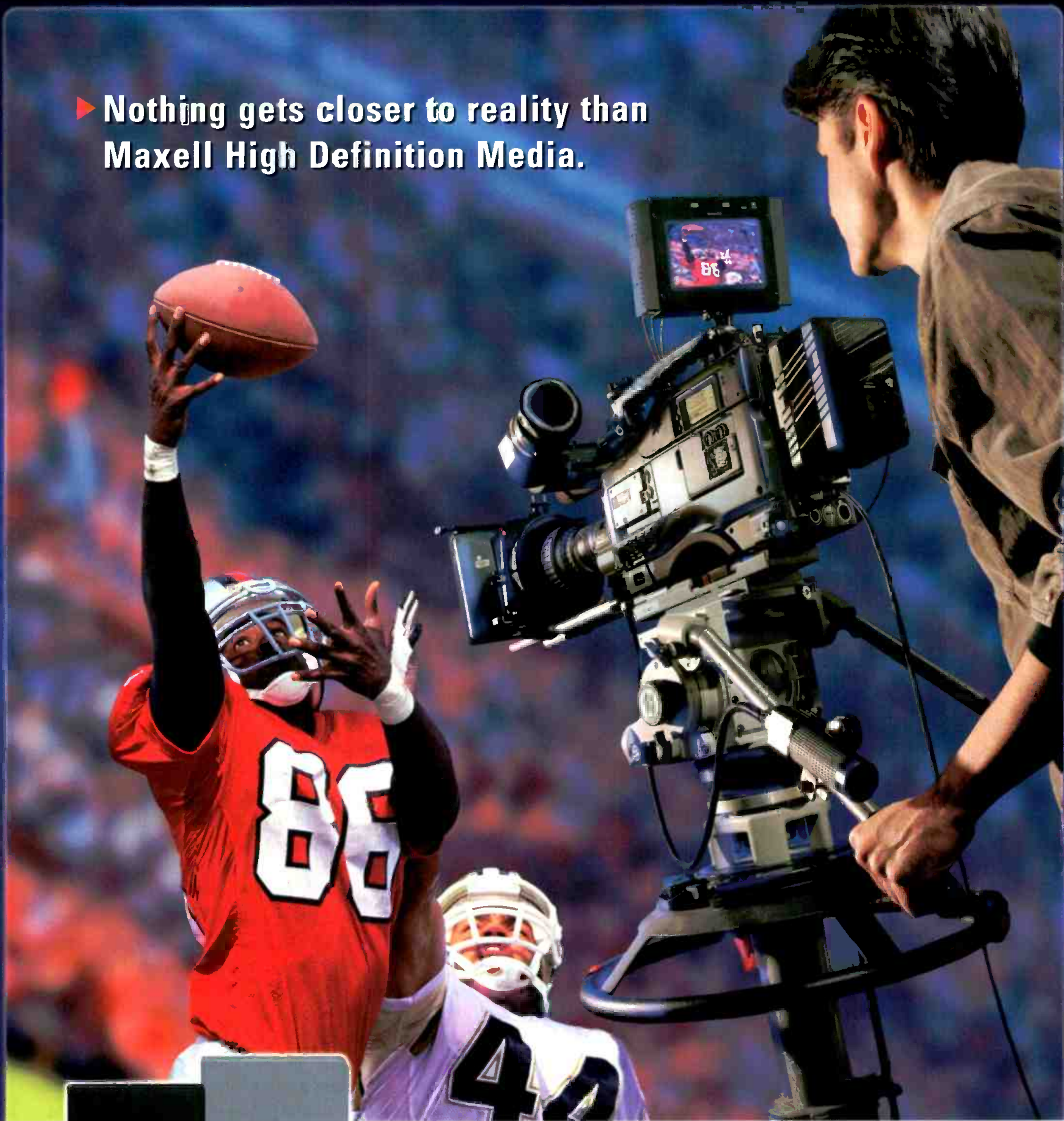
Freezeframe

Provide the introduction years (typically the NAB where first shown) for the following SD digital tape formats. Hint, see Graham Jones' new book, *A Broadcast Engineering Tutorial for Non-Engineers*, Focal Press. The book is also available from the NAB publications store.

D1, D2, D3, Digital Betacam, D5, DV and MiniDV, DVCPRO, DVCPRO50, D9 Digital-S, DVCAM, Betacam SX, Digital8 and IMX.

Readers submitting winning entries will be entered into a drawing for *Broadcast Engineering* T-shirts. Enter by email. Title your entry "Freezeframe-May" in the subject field and send it to: editor@primediabusiness.com. Correct answers received by July 1st, 2005 are eligible to win.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124
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Ghosts of brands long gone

The engineer leans into the biting Las Vegas wind and presses toward his goal. Off in the distance, he sees his target: the Las Vegas Convention Center. His mission: Acquire new technology for his station. The list is long and time is short as our intrepid technology manager challenges the elements in his quest to get the best products he can afford from a vast array of providers.

He examines his shopping list: editing system, automation, cameras, production switcher, graphics platform and servers. It's a long list because his station hesitated to buy new technology after it purchased a DTV transmitter two years ago. Now it's time to completely renovate the facility and bring it into HDTV.

Unfortunately, our engineer isn't looking ahead; he walks smack into a light pole and falls unconscious.

He dreams … The convention hall is just ahead. It has three exhibit areas: the North, South and East halls.

"My first stop will be to see the new Ampex DCT VTRs. Then it's cameras," he thinks. His list includes several players: Ampex, RCA, Philips, BTS, and Bosch. "Certainly the Philips LDK-54 video recording camera will be a hot item," he says to himself.

Also on his must-see list: the Dubner CBG-2 and Abekas A51 graphics and effects systems. For production switchers, it's the Grass Valley 3000 or Abekas 6000.

Server options include an AirSPACE from Pluto or a ColorGraphics DP4:2:2. Then there's the new company Pinnacle and their MediaStream. "Didn't that used to be a Hewlett-Packard MediaStream?" he wonders.

Perhaps he'll buy a new Dynair Dyna Mite analog router. Oh, don't forget automation systems. There's Vital, Louth, Lake Systems, Columbine, Encoda — and consider Jefferson-Pilot for traffic. Lots to choose from.

Our engineer reaches the convention center and enters the main hall. That's funny; there are only two halls, a radio hall and a TV hall. He rubs his head and enters the TV hall. His eyesight fuzzy, the hall appears more like a ghost town, with only a few people on the exhibition floor. Company banners float in space: RCA, Ampex, Dynatech, Editing Machines …

He needs a landmark, so he decides to look for Ampex, where he's sure he'll be able to get his bearings and see the DCT VTRs. But where's Ampex? He sees Abekas, but no, that banner morphs into Accom. A nearby Discreet banner transforms into AutoDesk.

"Who the heck is AutoDesk?" he asks himself.

To his right, Pinnacle fades into Avid. Is this a dream? Have companies changed names? No, that can't be. Where are the good ol' American broadcast brands like RCA, General Electric, Ampex and Pacific Recorders? They are gone and have been replaced by newcomers like Sony, Panasonic, Thomson, JVC and Avid. Fortunately, Grass Valley seems to have returned from the dead, he notices.

The convention booths slowly slip away as our engineer begins to wake from his bumped head.

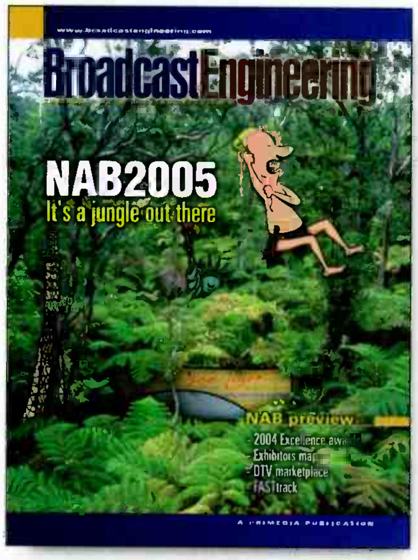
"What happened?" he asks Susan, his station manager, who's standing next to him.

"You bumped into that pole and went out like a light. You were calling out names I've never heard of — RCA, Ampex, Dynatech, Dubner — who are they?" she asks.

"Ghosts I think," the engineer replies. "Ghosts of brands long gone." BE

Brad Dick
editorial director

Send comments to: • editor@primediabusiness.com • www.broadcastengineering.com



Set me straight, please

Dear Mr. McGoldrick:

I enjoyed reading your article in the March issue of *Broadcast Engineering*. After recently visiting showrooms of a few reputable, nationwide retailers, I am even more confused than to begin with. Here is my dilemma: I reside in a rural setting without cable service and I do not consider DIRECTV as a viable option. Therefore, I rely entirely on VHF & UHF analog/NTSC OTA reception from several TV translators operating in my area and occupying spectrum between channels 2 and 61. Occasionally, some of these translators transmit programs in the widescreen mode. What combination of monitor resolution and type of the receiver/tuner (NTSC, ATSC/QAM) integrated or not, will result in the best possible quality TV picture on Plasma TV with 16:9 aspect ratio receiving only VHF & UHF analog/NTSC OTA broadcasts?

JOHAN SORENSSEN

Paul McGoldrick responds:

You have entered the perfect world of retail spin. There is nothing to be done to improve the display of an NTSC over-the-air (or cable) signal other than to use the best decoder you can afford. A decoder built in to the receiver is probably fair to good, but you would do better with a professional decoder where the filtering is optimized — but the price can be daunting. The transmitted/displayed aspect ratio has nothing to do with this question. It is what it is.

Personally, watching a decoded NTSC signal on a 42in display would drive me close to insanity.

Going the distance

Mr Robin:

Would the use of unbalanced 75Ω cable for AES transmission still allow for long distances without any loss? It's been practice to use long cables, 50m or 100m, for AES transmission on balanced 110Ω cable with XLRs, but I was at SSL in the UK, and they told me they were using BNCs with 75Ω cable for their digital transmission.

BEST REGARDS
SERGIO CASTRO
REFLEXION ARTS, SPAIN

Michael Robin responds:

110Ω impedance in AES/EBU digital audio distribution is outdated. In an ideal world, impedance matching, return loss, cable losses and tightly controlled source signal amplitude specifications don't matter. So the initial AES/EBU standard that specified 110V source impedance, 250Ω destination (input) impedance, up to five 250Ω input impedance receivers in parallel with an unspecified cable impedance as well as widely varying source signal amplitudes would be acceptable.

In the real world, this is not the case! Due to poor and unpredictable performance, as a result of inevitable and unpredictable standing waves, the standard was revised keeping the same source impedance of 110Ω but changing the receiver input impedance to 110Ω and advising not to use more than one receiver across the feeding cable. The cable impedance was still unspecified, and the wide source signal amplitude variations still remained fairly loose. Things work most of the time, but the performance is unpredictable when the expected cable length is 50m to 200m. This might be acceptable in a small studio but not in a large teleproduction facility with varying and unpredictable signal distribution patterns.

Video guys are accustomed to tightly specified impedances, return loss and signal source amplitude. To satisfy them, a 75Ω unbalanced digital audio signal distribution standard was developed. This standard tightly specifies the source impedance, coaxial cable impedance, receiver input impedance, return loss and source signal amplitude as is customary in a well designed video facility. As a result, the typical acceptable cable length is 1000m.

Now one can find 110Ω equipment, 250Ω equipment and 75Ω equipment, which are essentially incompatible, so a wide variety of impedance and signal amplitude adapters are available on the market to help the knowledgeable user. It is surprising that the 110/250Ω unbalanced digital audio distribution concept is still alive today. Old habits die hard! **BE**

January Freezeframe:

Q. By what date must stations have fully implemented the ATSC A/65B PSIP standard?

A. February 1, 2005

Winners:

Karl Sargent, CA Oregon Broadcast
Rich Brochman, KESQ TV-3
Rich Lohmueller, Harris

Test your knowledge!

See the Freezeframe question of the month on page 10 and enter to win a *Broadcast Engineering* T-shirt.

Send answers to *bdick@primediabusiness.com*

Affordable HD at NAB

BY CRAIG BIRKMAIER

The buzz at NAB2005 involved two converging themes: IT and HD. The information technology revolution is gobbling up what is left of traditional video-centric products targeted at broadcasters and the "new media" professionals that now dominate NAB attendance. Driven by massive volumes and the reality that HD video is just another form of data to be processed, products based on IT technologies now dominate the show floor. Computers have had high-resolution progressive displays for years. Apple Cinema Displays are used routinely to create HD video programming using Apple's Final Cut Studio tools, which now include Final Cut Pro 5, Soundtrack Pro, Motion 2 and DVD Studio Pro 4. Apple boldly claims users can "edit anything," and industry partners are stepping forward to put this claim to the test.

Coming into NAB, the HDV format was the big buzz, with Sony claiming to have shipped more than 30,000 of its three-chip 1080i HVR-Z1U camcorders. Apple announced support for long-GOP MPEG-2 editing in Final Cut Pro, the compression technology that allows HD images to be recorded at 25Mb/s onto standard DV tapes. But HDV appears to be more of a marketing term than a format, as a variety of incompatible products were announced that use long-GOP MPEG-2 to record a variety of HD formats at a variety of bit rates.

JVC introduced the GY-HD100U, an HD camcorder that uses three 1/3in progressive scan sensors to acquire images at 1280x720 at 24p. These images can be recorded on standard DV tape using long-GOP MPEG-2 compression. However, 1280x720 at 24p is not part of the original HDV specification created by JVC, Sony, Canon and Sharp. The new JVC camera is also capable of outputting 1280x720 at 60p, but this cannot be recorded using the internal DV tape drive. JVC also showed a prototype of a new HD ENG camera that will record long-GOP MPEG-2 at 25Mb/s to DV tape and at higher bits rates to a hard disk drive to support the demands of higher frame rates.

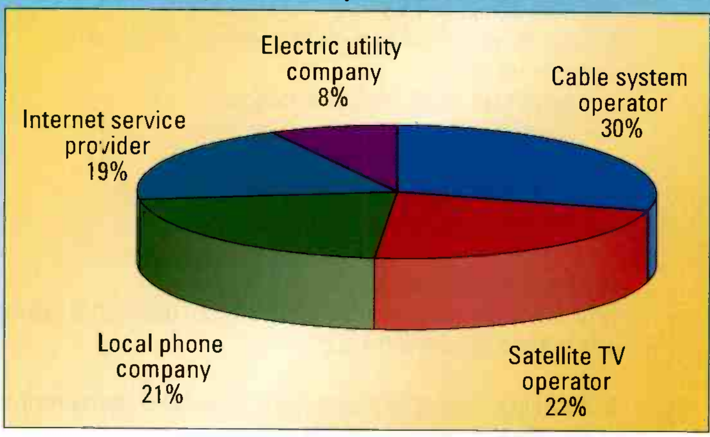
> **The information technology revolution is gobbling up what is left of traditional video-centric products targeted at broadcasters and the "new media" professionals ...**

The HD camcorder creating the biggest buzz in affordable HD at NAB2005 does not use long-GOP MPEG-2 compression or tape. Panasonic showed a prototype of a P2 HD camcorder, which records a variety of HD and SD formats to solid state memory cards using the companies trio of DVCPRO intraframe codecs: DVCPRO 25 (SD 4:1:1), DVCPro 50 (SD 4:2:2) and DVCPRO HD (100Mb/s for multiple HD formats). The AG-HVX200 camcorder will feature three 1/3in progressive sensors. The actual sensor resolution has not been announced. Complementing Apple's edit anything theme, the AG-HVX200 supports the following formats: 1080/60i, 30p and 24p; 720/60p, 30p and 24p; and DVCPRO 50, DVCPRO or DV (480i); and 720p

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

Bundled TV, phone and Internet poll

Cable system operators top list for best service and value



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mode (in which it may also capture at variable frame rates like Panasonic's Varicam).

Broadcast Engineering will provide more detail on these and other HD camera/camcorder product introductions in our June NAB wrap-up issue.

1080/60p

Interlace survived the transition to HD because of the difficulty and cost associated with acquiring and displaying HD images with more than 1000 lines. When the Japanese developed the 1125/60 HD systems in the late '70s, virtually all displays were CRT-based, and the scan rates associated with progressively scanning 1000 lines at 60fps were difficult to support in both professional and consumer products.

The HD trend: flexibility. This Panasonic AG-HVX200 camcorder records in a variety of formats.

Web Links

JVC ProHD GY-HD100U
http://pro.jvc.com/prof/Attributes/press_res.jsp?tree=&model_id=MDL101539&itempath=&feature_id=08

Panasonic AG-HVX200
www.panasonic.com/webapp/wcs/stores/servlet/prModelDetail?storeId=11301&catalogId=13251&itemId=93190&modelNo=Content04142005103002811&surfModel=Content04142005103002811

Sony HVR-Z1U
http://bssc.sel.sony.com/BroadcastandBusiness/DisplayModel?id=78439

Faroudja DVP-1080 HD Digital Video Processor
www.faroudja.com/prod_dvp-1080.phtml

Gennum GF9330 High Performance SDTV/HDTV Deinterlacer
www.gennum.com/ip/parts/gf9330.htm

Silicon Optix Realta chip with Teranex Hollywood Quality Video
www.siliconoptix.com/chipProducts/Realta/PressRelease/realtapressrelease.cfm?CFID=&CFTOKEN=1e0c36477e50e9fd-8DCCFA52-7E90-E2A3-B59455958728530E

NHK, which did most of the research behind the 1125/60 system, found that a progressively scanned system with fewer lines would provide the same benefits. However, it opted for 1125 interlaced lines for many of the same bandwidth conservation reasons that contributed to the choice of interlace for the television systems we have been using for nearly a century. Interlace is a crude compression scheme that trades off spatial resolution for temporal resolution. However, modern digital compression techniques actually work better with progressively scanned sources.

Modern display technologies are now up to the task of displaying 1920x1080 pixels (or more) at 60fps to 75fps. Apple's 30in monitor has plenty of room for a 1920x1080 window inside its spacious 2560x1600 raster. Several consumer electronics manufacturers have announced new HD rear- and front-projection systems using the new 1920x1080 at 60p DLP chip from Texas Instruments.

The ability to display HD images at these high spatial and temporal resolutions does not necessarily mean that 1080/60p acquisition and production tools are imminent, or even necessary for most applications. In reality, 720p is more than adequate for most consumer displays. The additional samples are only necessary when the screen size is larger than 70in diagonally or when the viewer is sitting close to the screen, as is the case for high-resolution computer displays.

For applications where 1080/60p makes sense, upconversion from other HD formats produces excellent results. The goal is not to present more information per se, but to eliminate the perception of the raster when it is blown up to large sizes. The ability to de-interlace video formats of various resolutions for presentation on progressive displays is one of the most important developments in the digital television transition.

Most of us still watch programs that are delivered using interlaced SDTV formats. Thus, it is critical to de-

For applications where 1080/60p makes sense, upconversion from other HD formats produces excellent results.

interlace this content for presentation on the wide range of new display technologies that are replacing the venerable old CRT. In addition to de-interlacing, many of these image-processing chips also perform 3:2 pulldown removal for 24p sources and other forms of advanced image processing to improve the quality of displayed images in both SD and HD.

One company exemplifies the progress that has been made in this

(Continued on page 22)

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(Continued from page 18)
area over the past decade. Teranex, an image processing company spun out of Lockheed Martin in the late '90s, developed a variety of image processing algorithms to run on the specialized image processing chips Lockheed developed for military applications. As the HD era began, Teranex challenged video industry veterans, such as Snell & Wilcox, with platforms to handle de-interlacing and interformat conversions. For the past three years, Teranex has been working with Silicon Optix to develop a chip capable of performing 1 trillion operations per second for both professional and consumer applications. Silicon Optix acquired Teranex last year, and the companies introduced the Realta chip at CES. The chip is being designed into several upscale consumer products, offering the same capabilities to consumers that broadcasters paid six figures for at the turn of the century.

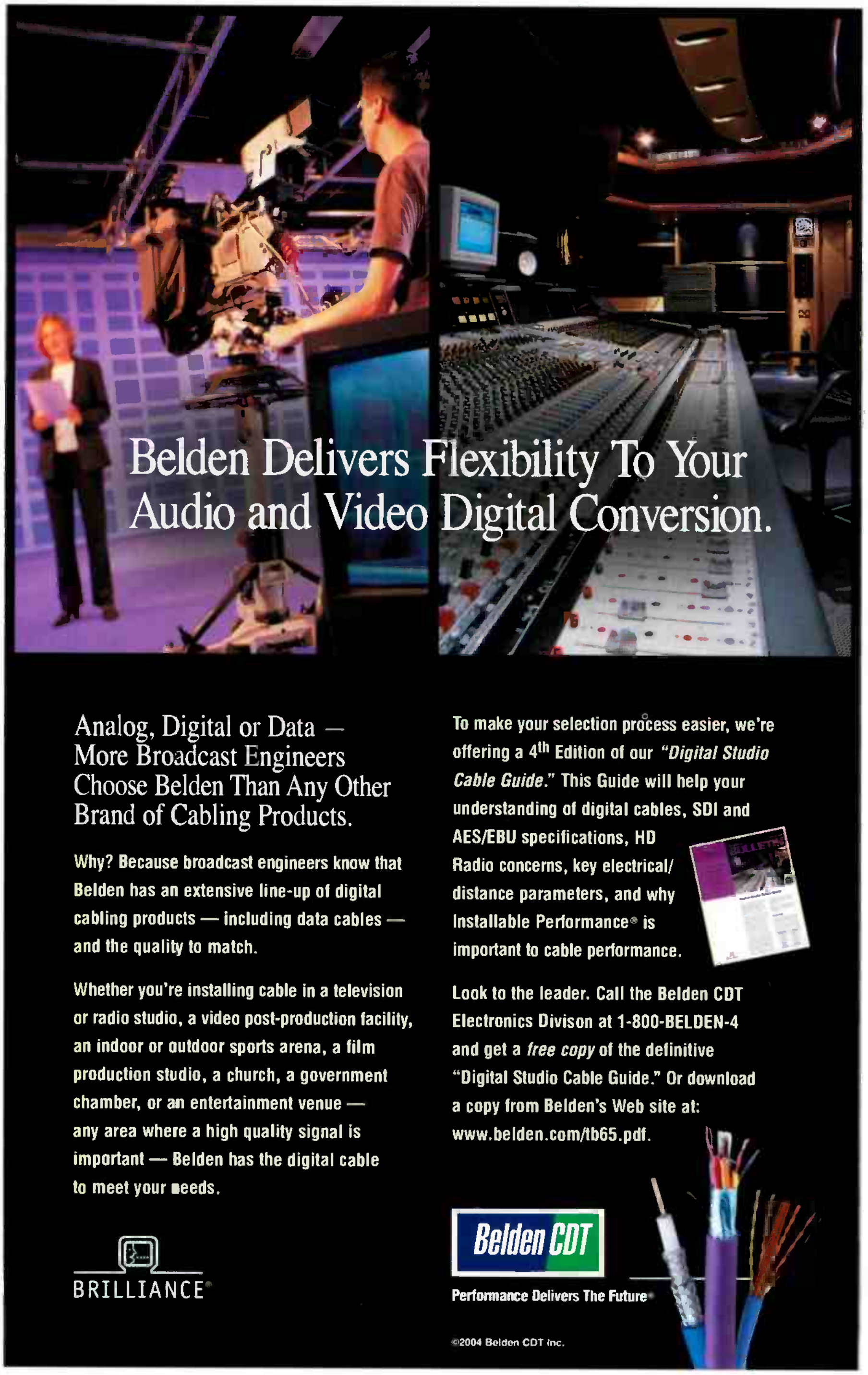
Many camcorders now support the new HDV format, including the HVR-Z1U from Sony.

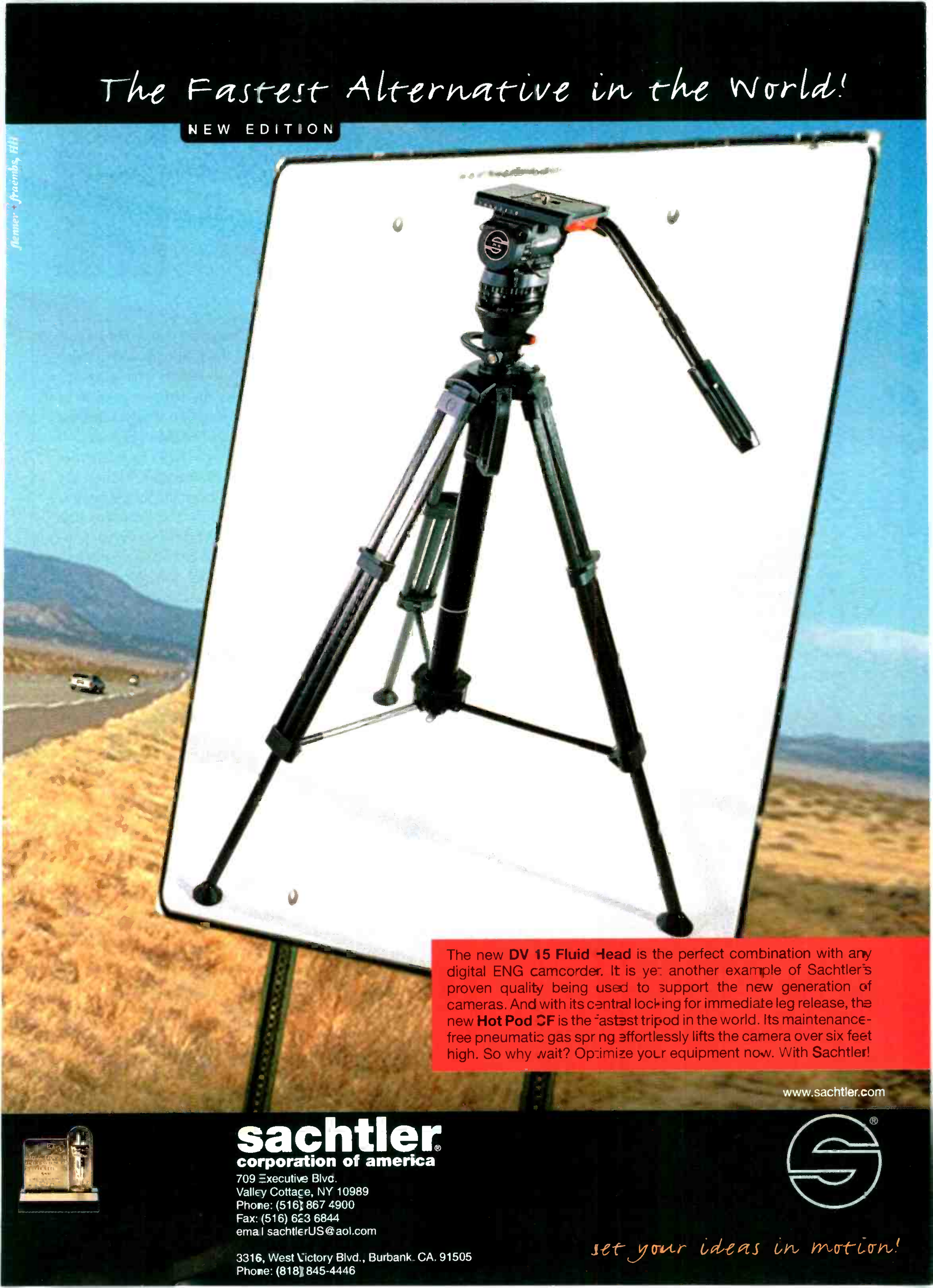
On a similar note: Faroudja, now a subsidiary of Genesis Microchip and Gennum, has also introduced powerful new image processing chips that are capable of converting virtually any video source to 1080/60p.

There has been much progress in the realm of high-resolution image acquisition and display as the IT revolution gobbles up the world of video as w know it. B

Craig Birkmaier is a technology consultan at Pcube Labs, and he hosts and moderates the OpenDTV forum.

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

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FCC stresses emergency information obligation

BY HARRY C. MARTIN

The FCC hit three San Diego TV stations with fines ranging from $20,000 to $25,000 for failure to make emergency information accessible to people with hearing disabilities. Shortly after those fines were announced, the commission issued a reminder to broadcasters, cable operators and satellite television services that they are required to make emergency information accessible to people with hearing and vision disabilities.

"Emergency information" is defined by the FCC as "information about a current emergency that is intended to further the protection of life, health, safety, or property, *i.e.*, critical details regarding the emergency and how to respond to the emergency." While the primary focus is on local matters, on occasion, matters of national importance may also be of local concern and could, thus, trigger this requirement.

The types of situations that might give rise to emergency information include tornadoes, hurricanes, floods, tidal waves, earthquakes, icy conditions, heavy snows, widespread fires, discharge of toxic gases, widespread power failures, industrial explosions, civil disorders, school closings and changes in school bus schedules arising from such conditions. The FCC emphasizes that this "list of emergencies is not intended to be exhaustive."

According to the commission, in order to provide the necessary information to people with hearing disabilities, TV stations and other video providers must use captioning, crawls, scrolls or the like. Emergency information should not block any closed captioning, and vice versa.

As for people with vision disabilities, video distributors must aurally describe the emergency information in the main audio if the information is provided during a newscast. If emergency information is provided in some other context (e.g., by an emergency crawl or scroll), it must be accompanied by an aural tone.

The FCC's recent reminder is noteworthy because it says nothing about any agency deference to the "good faith judgments" of TV licensees. When the commission first adopted requirements in this area, it stated, "In determining whether particular details need to be made accessible, we will permit programmers to rely on their own good faith judgments." That language suggests that a reasonable measure of discretion was left to video distributors to decide what elements of emergency information need to be specially transmitted. That is what the San Diego TV licensees believed.

But in the San Diego forfeiture decisions, the commission limited the scope of that good faith judgment dramatically. While the licensees had provided the required emergency information for the hearing disabled in its most essential emergency broadcasts, they had not broadcast the necessary access information in other emergency programming. The licensees argued that they were merely exercising the good faith judgment that the FCC had incorporated into the standard. The FCC was not persuaded and suggested that the licensees' interpretation of that language was too "expansive." Not surprisingly, the follow-up reminder does not even allude to the good faith judgment question.

The recent fines in combination with the reminder send a clear signal to video distributors: The commission expects all emergency information transmitted conventionally will also be made accessible to persons with hearing or vision disabilities. **BE**

Dateline

June 1 is the deadline for television, LPTV, Class A and TV translator stations in Michigan and Ohio to file their 2005 renewal applications, biennial ownership reports and EEO program reports.

June 1 also is the date TV stations in Illinois and Wisconsin must begin their pre-filing renewal announcements in anticipation of their renewal application filing date of August 1.

July 1 is the DTV buildout deadline for TV stations in top-100 markets that are affiliated with ABC, CBS, NBC or Fox. After that date, affected stations will lose interference protection beyond the service areas of their then-existing facilities.

Round 2 DTV channel elections will be solicited by the FCC later this year, after Round 1 elections are fully processed.

Harry C. Martin is president of the Federal Communications Bar Association and a member of Fletcher, Heald & Hildreth PLC, Arlington, VA.

SEND Send questions and comments to: harry_martin@primediabusiness.com

DIGITAL HANDBOOK

Carrying the bits

BY MICHAEL ROBIN

Figure 1 shows the simplified block diagram of a Rec. 601 4:2:2 encoder. Each of the three component video channels (E'_Y, E'_{B-Y} and E'_{R-Y}) consists of a low-pass (anti-aliasing) filter and the associated A/D. A clock generator controls the sampling process. The output of each converter features a conductor (pair of wires) for each of the bits plus an additional conductor carrying the clock. The clock is required to synchronize the various serializer functions as well as the D/A converters in the decoders.

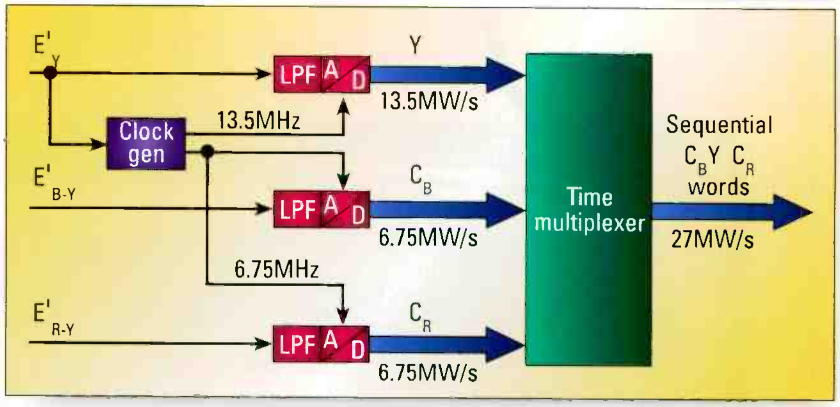


Figure 1. Simplified block diagram of Rec. 601 4:2:2 encoder with time division multiplexed 27MW/s bit-parallel output

Information is carried word-by-word, meaning the bits are carried in parallel. This requires a large number of conductors of equal length to ensure that the bits arrive in time at the destination. This is relatively easy to do inside a studio, but it creates a nightmare in a large teleproduction center. It is feasible to carry the bits in parallel in a studio environment, but not on a telco distribution system.

The information is carried word-by-word, meaning the bits are carried in parallel.

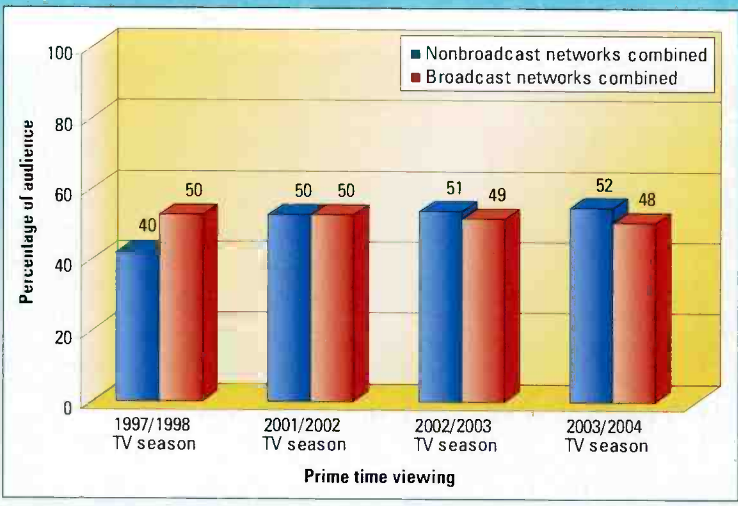
Therefore, since the beginning of digital technology, various scenarios were developed aimed at using a single conductor to carry the bits in sequence (bit-serial). All of them have something in common: They use the concept of self-clocking, which means that the bit-serial signal has to carry information allowing the receiver to regenerate the missing clock signal.

FRAME GRAB

A look at tomorrow's technology

Audience share statistics

Nonbroadcast network viewing is on the rise



Source:FCC www.fcc.gov

The channel coding

The channel coding describes the manner in which the ones and zeros of the data stream are represented on the transmission path. There are many channel coding standards. They all aim at optimizing some aspect of the bit-serial digital signal, such as the spectral distribution, the DC content and the clock recovery.

The simplest and most commonly used channel code is NRZ. NRZ is exemplified by logic "one" having a well-defined DC level and logic "zero" having a well-defined lower DC level. The bit-serial digital signal is self-clocking.

The receiver contains a clock regenerator. The regenerator recreates the

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clock through a phase-locked-loop (PLL) controlled oscillator (VCO). The PLL derives its reference from the zero-to-one-to-zero digital signal transitions. The NRZ code may result in long strings of ones and zeros. These long monotonous data strings have no transitions, resulting in long periods of time during which the PLL reference is not refreshed.

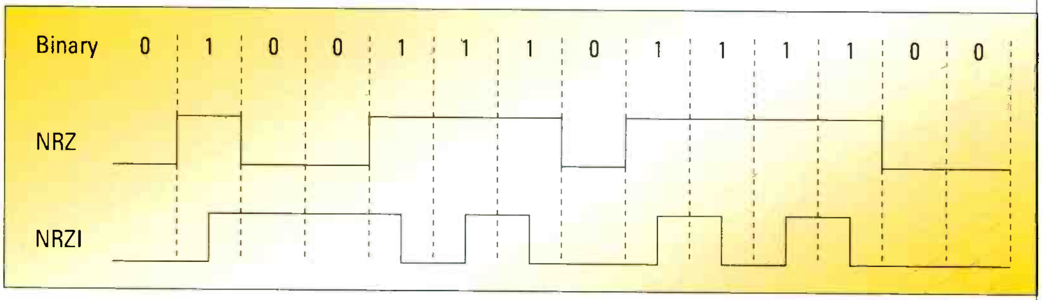

Figure 2. NRZ- and NRZI-channel coding characteristics

The accurate sampling of the bit-serial digital signal in the receiver during these periods depends on the stability of the clock VCO. In addition, the NRZ code has a zero frequency (DC) component, which varies with the nature of the data stream, as well as a significant low-frequency content, making it inappropriate for AC-coupled receivers. For these reasons, the NRZ code is not used in its basic form in bit-serial digital video transmissions.

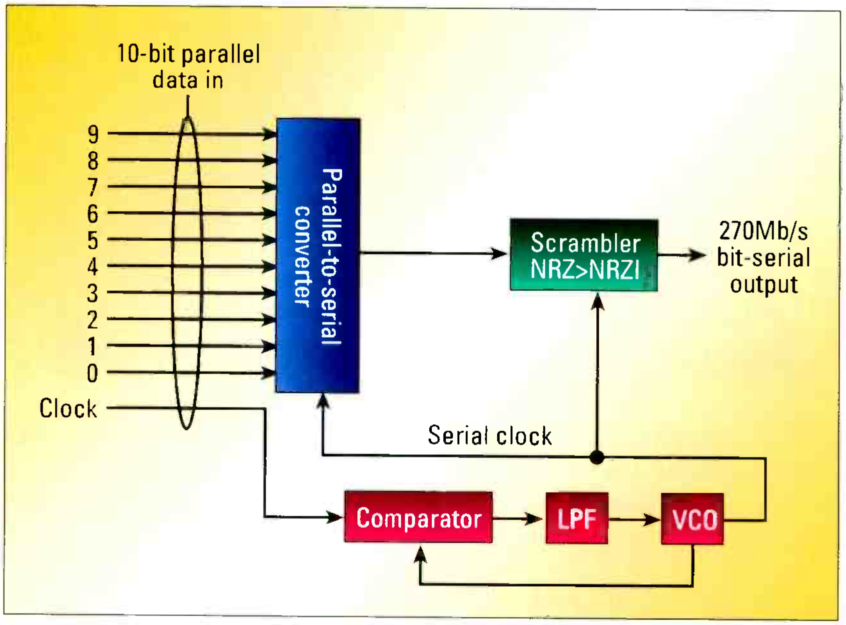

Figure 3. Simplified block diagram of a Rec. 601 4:2:2 serializer

Bit-serial digital video transmissions use a derivative of the NRZ code, the non-return-to-zero inverted (NRZI) code. Figure 2 above shows an example of an NRZ-coded digital signal and the derived NRZI-coded signal.

NRZI codes logic zeros as a DC level (zero or one) and logic ones as a transition. When the NRZ-coded digital signal is a long string of ones, the derived NRZI-coded signal is a square wave at one-half the clock frequency. As shown, for a given binary sequence, an NRZI-coded signal has more transitions per unit of time than an NRZ-coded signal, resulting in improved clock regenerator PLL operation.

Provided that the system limits the maximum number of zeros in the data stream, the receiver clock regeneration works quite well. The standards meet this requirement by reserving the all-zero word for sync purposes only. The NRZI, while superior to the NRZ coding, still has a DC component and a significant low-frequency content.

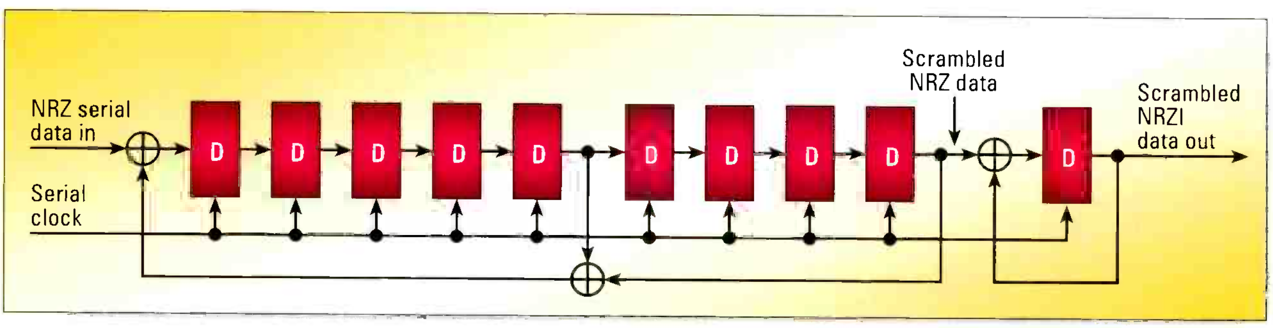

Figure 4. Block diagram of a scrambler

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The scrambling concept

A further improvement in the receiver clock recovery is obtained through scrambling. The scrambler randomizes long sequences of zeros and ones as well as repetitive data patterns, which could result in clock regeneration difficulties. It helps eliminate the DC content and provides sufficient signal transitions for reliable clock recovery.

Figure 3 on page 28 shows the block diagram of a Rec. 601 4:2:2 serializer consisting of a scrambler, followed by an NRZ-to-NRZI encoder. The scrambler produces a pseudorandom binary sequence, which, in turn, is combined with transmitted data in order to randomize it. It consists of a nine-stage $G1(X) = X^9 + X^4 + 1$. The scrambler can produce long runs of ones. These are converted to transitions by an NRZ-to-NRZI converter consisting of

A further improvement in the receiver clock recovery is obtained through scrambling.

a single stage shift register with an XOR gate. The polynomial of the NRZI converter is: $G2(X) = X + 1$.

Figure 3 shows a simplified block diagram of a Rec. 601 4:2:2 serializer

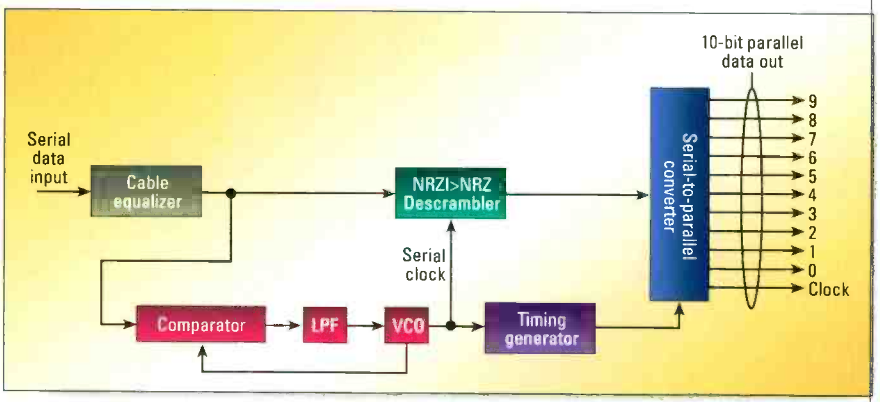

Figure 5. Simplified block diagram of a Rec. 601 4:2:2 deserializer

shift register (nine sections of clocked Master Slave D-Flip-Flop marked D in the diagram) with associated feedback. The feedback signals are combined by "Exclusive OR" adders (marked ⊕ in the diagram) with the following input versus output truth table:

0 (at input A) + 0 (at input B) = 0 (at output)
0 (at input A) + 1 (at input B) = 1 (at output)
1 (at input A) + 0 (at input B) = 1 (at output)
1 (at input A) + 1 (at input B) = 0 (at output)

The scrambling function is classified using a shorthand method of describing the feedback connection known as the "Characteristic Polynomial." For the nine-stage register illustrated in Figure 4 (page 28) the polynomial is:

using the scrambled NRZI. The resulting signal is often called pseudo-noise because it has a noise-like spectrum and, as a result, the required bandwidth remains unchanged. By comparison, the AES/EBU digital audio signal distribution uses a different channel coding called the Bi-phase Mark (BPM), which doubles the bit rate and, therefore, the required bandwidth. While this is acceptable with the relatively low bit rate of digital audio (3.072Mb/s), it is unacceptable with the high bit rates of SDTV (270Mb/s) and HDTV (1.485Gb/s).

Figure 5 shows a simplified block diagram of a Rec. 601 4:2:2 deserial-

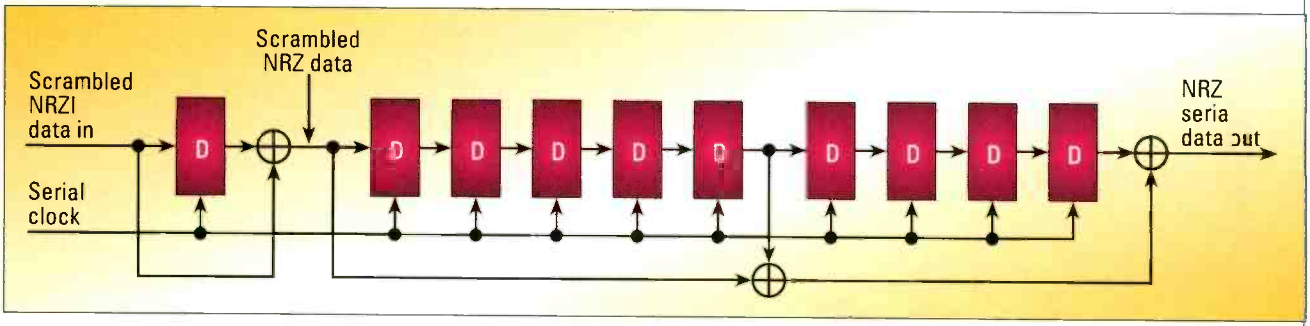

Figure 6. Block diagram of a descrambler

izer. Cable losses are rewarded by a self-adjusting equalizer. The original data is recovered by an NRZI-to-NRZ converter, followed by a descrambler.

Figure 6 above shows the block diagram of the descrambler. The logic arrangement is identical to the one used in the scrambler, except that feedforward is used instead of the feedback. The same random sequence, which is added to the signal before transmission, is subtracted at the decoder, resulting in the recovered data being identical to the original data. **BE**

Michael Robin, a fellow of the SMPTE and former engineer with the Canadian Broadcasting Corp.'s engineering headquarters, is an independent broadcast consultant located in Montreal. He is co-author of "Digital Television Fundamentals," published by McGraw-Hill and translated into Chinese and Japanese.

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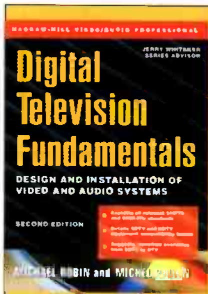
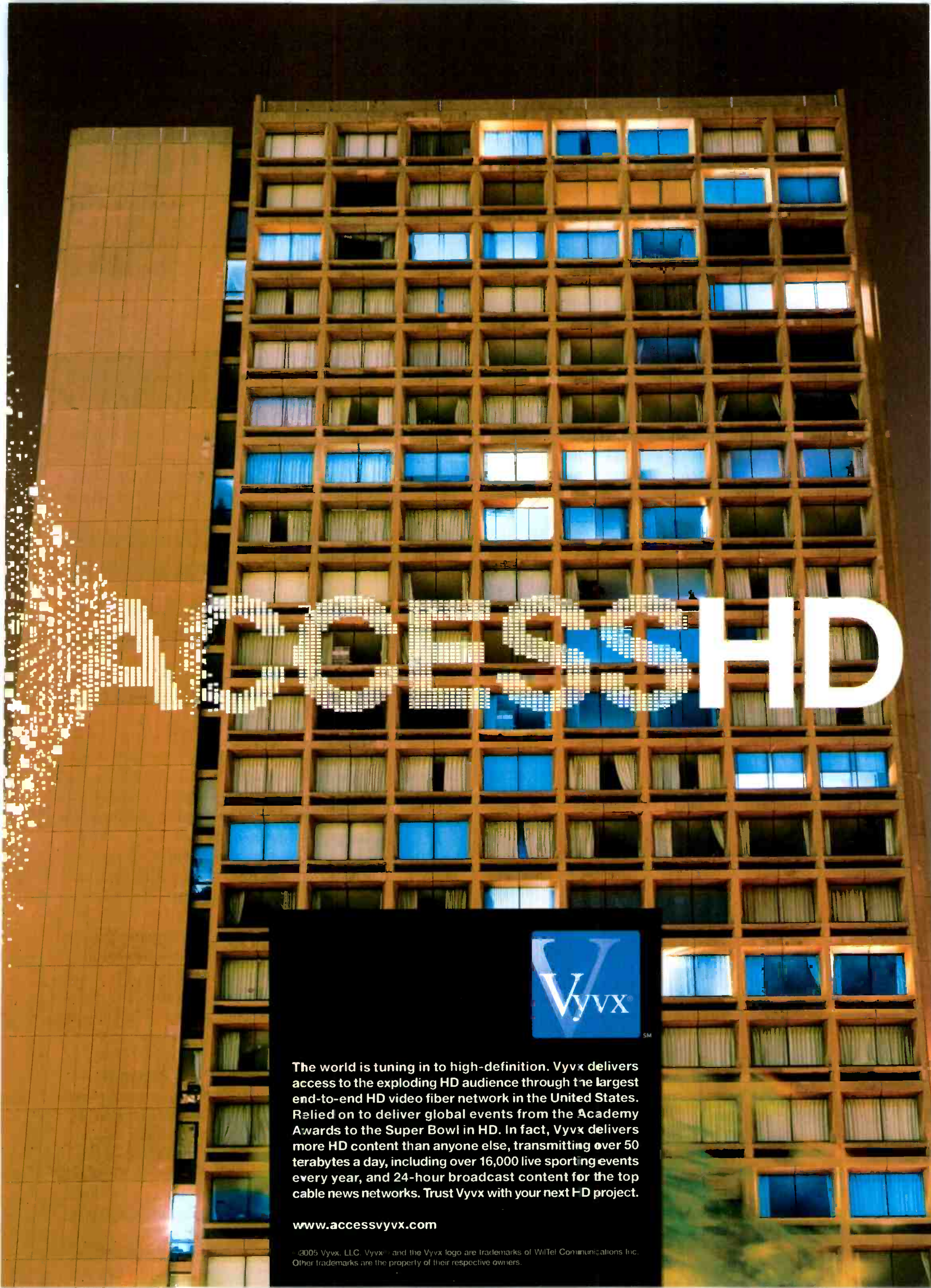


The Second Edition of Michael Robin's book may be ordered directly from the publisher by calling 800-262-4729. The book is available from several booksellers.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Workflow integration

BY BRAD GILMER

Recently, I was part of a team that launched a new, nationwide cable satellite music channel. Because we started from scratch, we looked at a number of different options for our facility.

In the end, we outsourced the origination and uplink of the channel. However, all management, programming, traffic, commercial sales and promotion are handled in-house. Because the channel is music video oriented, we decided to use a radio music scheduling system for programming the music elements, but a conventional traffic system to schedule half-hour and hour programming. Just to make things a little more complicated, we selected a hosted traffic system. The actual traffic computer is located at the traffic vendor's location, and we connect to it via the Internet. Figure 1 shows a simplified drawing of the configuration.

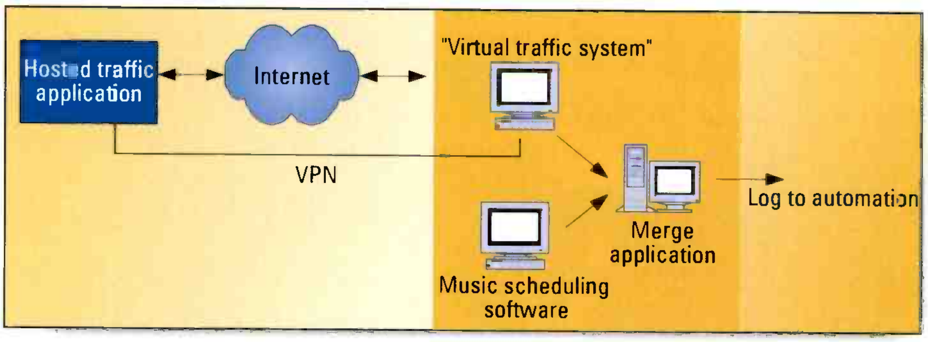

Figure 1. Simplified diagram of traffic system

This operation is different from many conventional television networks because of the music scheduling software. In radio, each piece of music in the library is classified into groups such as hot-hit, rock, oldie and so on. It is the responsibility of the program director to classify the music and to create clocks for different parts of the day. A clock describes what kind of events will be played in what order during any given 60-minute period. The program director creates several clocks for different times of day. For example, he or she may create clocks for morning drive, morning, day, evening drive, night and overnight. A clock might say, "Play an ID at the top of the hour, followed by a hot-hit, followed by a rock title, followed by another hot-hit, followed by an oldie, followed by a commercial break, etc."

The key to radio automation is that the scheduler module automatically places songs on the log based on the song's classification, the clock in use at the time, and other parameters such as "do not play this particular song more than three times in a 24-hour period." This saves a tremendous amount of manual work.

The key to radio automation is that the scheduler module automatically places songs on the log based upon the song's classification, the clock in use at the time, and other parameters.

While the music scheduling software works well, it does not contain all of the tools available in a television traffic system. Our music video network plays music video blocks, but it also airs conventional half-hour and one-hour precompiled multisegment shows. A television traffic system is the perfect tool to use in this environment. The challenge we faced was to get the two systems to work together. We decided to have the two systems create separate logs, and then merge them together into one log to send to our origination and playout facility.

In the end, the TV traffic system company modified an existing merging application so it would take the two logs and produce a final log. We required some custom development and while a few minor bugs remain, the system works well. I wish I could say the same for interfacing the traffic system to the automation interface.

As I mentioned earlier, we do not have the physical computer for the traffic system at our facility. Instead, the system is located in a data center maintained by the vendor. The traffic system clients at our facility connect to the hosted traffic computer over the Internet. We established a Virtual Private Network (VPN) between the two facilities — actually, between individual client computers in our facility and a router at the hosting location. Once the VPN is connected, we run a Citrix client application on the desktop. This client connects to a Citrix server at the hosting location. (Citrix

is an application that provides remote connectivity over the Internet.) When the connection is complete, traffic system users are presented with a virtual traffic system on their desktop.

As the traffic person works with the system, client session data is passed over the Internet between the host and the desktop. While overall the system has worked well, we have had unexplained interruptions in this virtual traffic system connection. We are still working to find the problem. It would be easy to blame the outages on the Internet, but this is a system with a number of components, so the problem may be at the hosting site, within the configuration of the Citrix environment, or in the desktop environment. Overall, the hosted solution has been satisfactory, but the interruptions have made work difficult at times.

By far, the most challenging part of this project has been the connection between the traffic system and the automation system. This should be a fairly straightforward interface. As you can see from Figure 2, we are exchanging playlists, dub lists and as-run logs between these two systems.

This is a *very* common interface requirement — I have been working with systems exchanging these sorts of lists for many years, and I assume you probably have, too. In this particular case, one of the vendors was almost completely unresponsive. Because each vendor had its own proprietary interchange format, something had to give. One of the vendors was willing to work with us. It had an interface that had worked with the other vendor's equipment in the past, so we gave it a try. It failed completely.

None of the traffic elements made it to the automation system. Obviously something had changed. We contacted the nonresponsive vendor, and after several weeks, it provided us with marginal support. After trying four or five different interface configurations, we were finally able to get information to pass between the two systems. We were successful but only with the most basic log elements. We still needed to pass secondary events to control IDs and logos. As soon as we added these elements to the log, the conversion failed. Once again, we contacted the nonresponsive vendor, and after quite some time, we were able to get things working but not without trial and error.

When the connection is complete, traffic system users are presented with a virtual traffic system on their desktop.

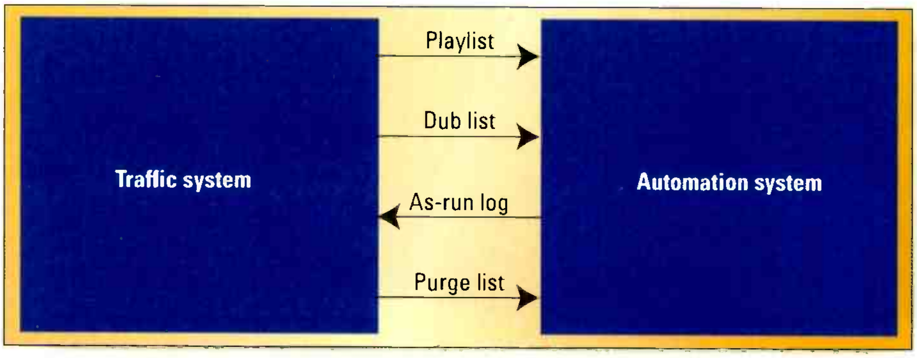

Figure 2. Typical interchange elements between traffic and automation

Not to belabor the point, but it turns out that our problems were not over. When we started working with as-run log data, we wrote a conversion that worked for a while but then quit. One of the assumptions we made about the as-run conversion was invalid, but there was no documentation of any kind on the as-run log format, so we had no alternative but to guess until we got it right.

Good news on the horizon

The good news is that there is a new group within SMPTE that is working to standardize data interchange. This group, called the Working Group on Data Exchange, has taken on the task of standardizing the various data exchange elements required in the broadcast environment. The group has more than 100 members and meets regularly. It has made a lot of headway in defining a data dictionary of interchange terms and XML schema for the exchange of things such as playlists, purge lists and as-run logs. The group is also developing a communications framework for interchange between different systems.

The focus of the group is on programming systems, automation systems, traffic systems and content delivery systems, though many other systems will also benefit from this standardization effort. Speaking as the head of a group of users who have provided input to the group, we are extremely pleased with the progress so far. When can we buy it? **BE**

Brad Gilmer is President of Gilmer & Associates, Executive Director of the Video Services Forum and Executive Director of the AAF Association.

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Pre-scaling graphics for HD editing

BY MIKE NANN

At first glance, the creation and scaling of graphics to the correct size for incorporation with HD video in a nonlinear editing system may seem straightforward. However, the adage "looks can be deceiving" comes to mind.

Graphics-related issues such as color space conversions, color sampling and pixel aspect ratios have been covered in detail before, and the full raster sizes for HD video frames are well-known — 1920x1080 and 1280x720. Simply create your graphics to these sizes, and you're ready to import them into your NLE — or so it seems.

While this simple process is usable for bringing HD graphics into modern editing systems, there often are internal factors within an NLE that can make this workflow less than ideal. For instance, prescaling full-size HD graphics to sizes other than the full raster may be advantageous both in terms of quality and productivity. Otherwise, some NLEs may perform some unexpected automatic re-scaling of the graphics that editors would otherwise prefer to control. And, on some NLE systems, prescaling the images may result in improved real-time layering and effects performance. Counterintuitively, in many cases, the best results in both quality and performance may be achieved by prescaling graphics to lower than full raster size, before bringing them into an NLE.

One size doesn't fit all

The key factor that can make prescaling HD graphics desirable relates to the frame size (in pixels) of the graphics, versus the actual frame size at which the NLE processes the HD video. For example, not all 1080i is created equally. While NLE operators may think they're mixing graphics and video of the same frame size, that might not actually be the case.

This issue arises when full-resolution (1920x1080 or 1280x720) graphics are mixed with HD video that is being processed natively in a compression format that has been subsampled from the full HD raster. While formats such as Panasonic's D-5 HD and Sony's HDCAM SR support the full raster (as does the HDV format in its 720p variant), many other common HD formats do not. For instance, HDV, as well as Sony's HDCAM, uses 1440 luma samples per line, for a 1440x1080 recorded frame size. DVCPRO HD subsamples to 1280x1080 in its 1080-line mode, or 960x720 for 720p.

If the nonlinear system works with media in any of these acquisition formats natively, the addition of a full-size graphic in the editing process may result in the mixing of a 1920x1080 graphic with video at a 1280x1080 or 1440x1080 frame size. Various formats and their native frame sizes are shown in Figure 1.

Similarly, as an alternative to processing HD media natively in its acquisition format, some NLE manufacturers offer their own compression schemes, optimized for post-production. While some of these codecs support the full HD raster, others are subsampled similarly to the acquisition codecs mentioned above.

This means that those subsampled formats will face the same frame size mismatch. Resolving this will invariably be handled automatically by the NLE. However, there are disadvantages to doing this that might make it preferable to avoid it in the first place.

Frame size (sub-sampled or full-raster) by format 1920x1080 full raster	
HDV	1440x1080
Panasonic DVCPRO HD	1280x1080
Panasonic D-5 HD	1920x1080 (full-raster)
Sony HDCAM	1440x1080
Sony HDCAM SR	1920x1080 (full-raster)
Avid DNxHD	1920x1080 (full-raster)
Canopus HQ	1440x1080
Leitch LWC-1	1920x1080 (full-raster)

Figure 1. Common acquisition formats and their native frame sizes

Letting the operator control the down-scaling of the graphic manually prior to importing into NLE provides better control of the scaling quality.

Scale up or scale down?

There are two fundamental ways to resolve the differing frame sizes of the graphics and the HD video: scaling the graphics down to the size of the video or scaling the video up to the size of the graphics. The particular method used varies between different NLEs, often influenced by the constraints of their internal pipelines. Both methods, however, have downsides.

In the first case, the NLE (internally, without user intervention) scales the graphic down appropriately (with the associated pixel aspect ratio change) to match the smaller frame size of the video content. On NLE systems that have internal processing limited to the subsampled raster size — such as systems that support only specific compressed HD formats — this is the only viable method. Because scaling a graphic is not a computationally intensive process, it can be handled quickly — likely without affecting the NLE's real-time performance. The question then becomes: Why not just let the NLE do it?

The answer: control over quality. Letting the operator control the downscaling of the graphic manually prior to importing into NLE may give you better control of the scaling quality. Many NLEs offer few (if any) options as to the scaling and interpolation methodologies for reducing the size of these images. These systems may provide operator controls for non-standard image sizes that the user specifies to be scaled, but they seldom provide adjustments for the internal behind-the-scenes format conversion.

In contrast, dedicated paint and graphics software usually offer a wealth of such choices. Different scaling algorithms offer a variety of results based on adjusting image characteristics, such as hard edges, smooth gradations and overall complexity. Algorithms, such as *nearest neighbor* or simple *pixel duplication/removal*, may be best for preserving hard edges, but can also result in harsh, jagged-looking images. Other image conversion methods such as *bi-cubic interpolation* offer smoother results and have variation within their implementations, which may help preserve both smoothness and detail, but may result in a visual "softening" of the image.

The advantage of prescaling from a graphics application is that the operator gets to visually determine which interpolation method will maintain the highest quality. Furthermore, graphics software often provide image filters that can reduce some of the undesirable side effects of downscaling. Some NLE systems offer real-time rescaling (hardware- or software-based) that can result in even better-quality results than common graphics software. However, as mentioned, this single re-scaling method might not be ideal for all graphics and offers no manual control.

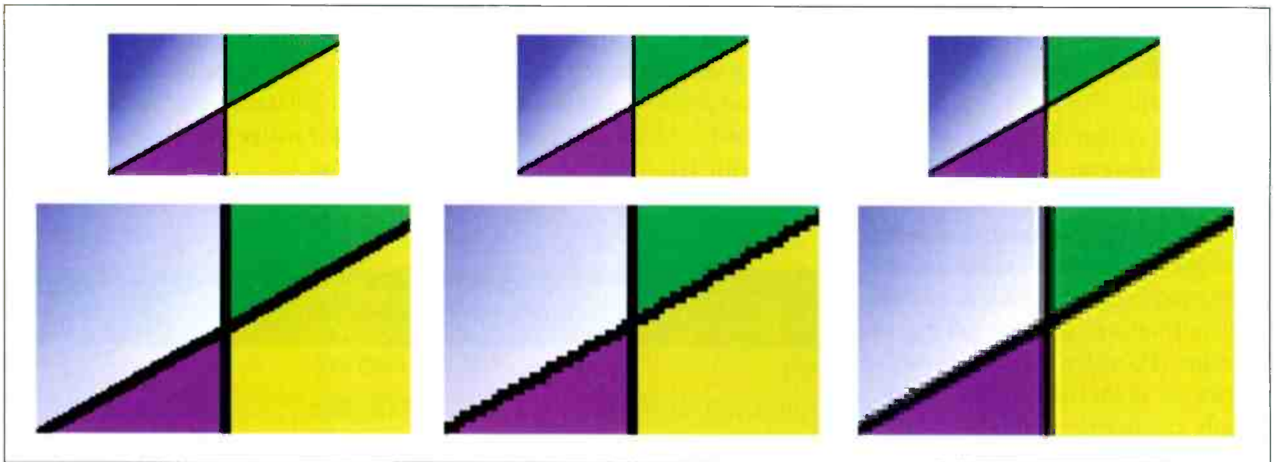

Figure 2. Scaling algorithm examples
Left: **Section of original 1920x1080 image, zoomed in to 300 percent (top) and 1200 percent (bottom).**
Middle: **Same section downscaled to 50 percent using nearest neighbor interpolation, zoomed in to 600 percent (top) and 2400 percent (bottom).The hard edges are retained, but the edges now appear more jagged.**
Right: **Same section downscaled to 50 percent using bi-cubic interpolation, zoomed in to 600 percent (top) and 2400 percent (bottom).The result is much smoother, without the jagged look of the nearest neighbor algorithm, but the edges are visibly softened.**

In short, while prescaling graphics down to a lower pixel resolution than the full HD raster does lower their overall precision (and thus quality), if an NLE is going to downscale the graphics anyway, then depending on your NLE's internal scaling methodologies, it may be advantageous to let the operator do it while maintaining control over the results.

Scaling up the video

The second way that the nonlinear editing can resolve the frame size mismatch is to expand the subsampled compressed video back to full raster for mixing with the full-size graphic. This has the advantage of maintaining the optimal quality. The downside is that it takes a lot more CPU horsepower to scale the multiple frames per second of HD video up to full raster size than it would a graphic. The net result is that the process can have a negative impact on an NLE's real-time performance, especially

Leitch's VelocityHD supports both uncompressed and full-raster compressed formats in real-time.

when the segment involves multiple video layers, each of which must be scaled up.

For example, on one NLE system, superimposing a 1920x1080 graphical overlay over an otherwise real-time segment of two layered video clips captured from DVCPRO HD requires rendering to get the video up-scaled for full-quality output. In contrast, superimposing a 1280x1080 graphical overlay over the same segment can be done in real-time.

Thus, prescaling the graphic down to 1280x1080 can save considerable time in the workflow process. This means that if a graphic is used as an overlay that runs the duration of an hour-long program, the short time taken to prescale the graphic may save having to render the entire project in the NLE, which is a long process.

Of course, prescaling the graphic down to 1280x1080 imposes a quality penalty (relative to letting the NLE process the graphic and up-scale the video at 1920x1080), but at least the usernow has the ability to make that decision. In high-demand environments, such as near-to-air applications, the need for real-time productivity may outweigh any loss in image quality.

When not to pre-scale

The above discussion outlines how prescaling can minimize or eliminate the problems associated with mixing full-resolution graphics with HD compressed video that has been subsampled from the full HD raster. However, some NLE systems support compression formats that can handle the full HD raster. These systems also feature full-raster internal processing, and can easily combine full-size HD graphics with video content in these compressed formats without any internal re-scaling of video or graphics. These systems maintain the same frame size (1920x1080 or 1280x720) throughout the workflow.

Similarly, NLEs that support uncompressed HD editing will also handle the full HD raster when using uncompressed media. Full-size HD graphics can be mixed with uncompressed HD video clips without re-scaling. Working with uncompressed HD video creates other issues. For instance, many of the new affordable HD editing systems offer better real-time layering and effects performance with compressed media than with uncompressed (if they support uncompressed at all). And naturally, working with uncompressed HD video requires far more storage and higher bandwidth than when operating with the compressed domain.

The moral of the story is that it is important to thoroughly understand how an NLE internally processes both graphics and video. This will help operators make the best decisions as to whether it's beneficial to prescale graphics before ingesting them into the NLE.

If the NLE provides full-quality, real-time performance on uncompressed video or full-raster compressed formats, then prescaling may not be advantageous. If, however, you plan to work in the compressed domain with subsampled compression codecs (including native acquisition formats), it may be beneficial in terms of quality or performance to prescale first.

Protect your HD

With the enhanced pixel resolution of HD, there is a natural inclination to take advantage of it by using detailed and intricate graphics. However, be careful because the extra detail can end up working against you when the finished HD project is distributed.

As explained above, if the NLE system will be working at less than full raster, the graphics may be downscaled or subsampled, resulting in lower horizontal resolution. It's also important to remember that, for the foreseeable future, a high percentage of HD content will be downconverted to SD for at least some of its distribution, which means a loss in both vertical and horizontal resolution.

Detailed graphics that look exceptional when created at full-raster HD resolution may lose considerable detail (making elements such as text all but unreadable) when converted to SD for playout.

Here are a couple of solutions. If all of the graphics will effectively be used as downstream keys in the NLE (superimposed over other video layers), it's often best to first downconvert a version of the finished HD project without the graphics in place. Then, add the graphical overlays (which have been specifically designed for SD) separately to this downconverted version. This process protects the HD version, while maintaining the best possible graphics quality and readability for the downconverted SD distribution.

This isn't always possible, of course, as graphics are often layered between other elements in the overall project. Even so, keep in mind the potential future downconversions that may occur when creating graphic elements, and you can avoid many of the associated pitfalls. **BE**

Mike Nann is the technical marketing manager, Professional Post Production, for Leitch Technology.

CREATIVE GROUP's HD enhancements

BY DAVID WEISS

The intensity of competition in the New York City video and audio post industries is constantly growing, creating a need for advanced approaches to the design, construction and maintenance of post facilities. Creative Group, a 10-year-old company with an equal focus on both video and audio post, recently completed an ambitious relocation intended to place it in the forefront of services for HD.

The plan

The initial causes for Creative Group's move from its older, two-floor, 11,000sq-ft home on Manhattan's East Side to a new, one-floor, 25,000sq-ft facility were twofold:

1) The company had run out of room for expansion in the old location.

2) The company felt that it would enjoy an increase in business traffic by moving closer to Times Square.

The new facility was to be comprehensive by post standard, encompassing a variety of editing suties. In order to maximize the effectiveness of having so many diverse but closely working resources in-house, one of the foremost design goals was improved

Creative Group's new facility has 20 rooms, which include two Sony HD linear editing suites, six Sony component digital linear editing suites and six Discreet flame/smoke nonlinear compositing/editing suites.

connectivity through a well-designed infrastructure. The company needed to be able to interconnect Windows-based, Mac-based (both OS 9 and OS X,) and SGI computers, providing all of them with conventional networking capabilities along the way.

Redesign

Adequate storage is key to the success of the nonlinear suites. The three ProTools suites work off of a Rorke 4TB SAN with a 40-slot AIT backup. Discreet logic platforms each have local 4TB RAIDs connected by gigabit Ethernet and supported by a Discreet Backdraft administrative workstation for archiving and utility functions. Although the facility is wholy digital in both HD and SD, analog signals can be accommodated when necessary. Five T1 lines supply connectivity and redundancy for Internet traffic and the VoIP phone system.

In addition to building an infrastructure that would be HD bandwidth-capable, the company had to be sure the facility would be fully functional for 1080i, 720p and 24p. The company installed an array of HD crossconverters, downconverters and upconverters in its suites that supported all three standards, including Snell & Wilcox HD5050, Leitch Juno 3800 and Panasonic UFC1800.

Moving from what had come to feel like a tight and cramped environment, the new design included more spacious rooms, benefiting both the clients and Creative Group talent — the latter of which the company places a high priority on attracting and retaining. The linear edit suites are 368sq ft, and the audio suites measure a spacious 675sq ft. The audio rooms' VO booths feature floating concrete slab construction with acoustically isolated walls and ceilings. Consoles designed by Sterling Modular have moveable wings to allow both the mixer and client to sit in the sweet spot during critical listening.

With it's newly remodeled facility, Creative Group designed and edited the 2004 promotion campaign for USA Network's "The 4400."

Benchmark Media Systems helped address the issue of RF interference, a strong possibility given the facility's Times Square location. The solution involved custom-designed audio patch bays from Audio Accessories, featuring capacitive decoupled signal shielding, shunting offending sources of interference to the ground. Mogami low-capacitance cable was used on all critical analog pathways, such as monitoring feeds, minimizing high-frequency roll-off on long wire runs, some of which extend as far as 200ft.

Consoles designed by Sterling Modular have moveable wings to allow both the mixer and client to sit in the sweet spot during critical listening.

In the machine room, Creative Group and Fiskaa Engineering were determined to head off HVAC complications. Measures were taken to ensure that all technical areas have adequate cooling capacity as well as redundancy, using twin 15-ton Liebert units. A star grounding system was installed, which connects directly to cold water pipes in the basement.

With a fast-growing roster of playback devices, including dedicated Digibeta and other available VTRs, the design team left plenty of capability, in terms of physical space, in router frames and surrounding racks to the outer system for HD and digital audio control routing expansion.

A single distributor, Sony, equipped the facility. Two systems integrators were used: Sony SIC and Max Video. Along the way, gear choices and workflow were closely interconnected. Creative Group's guiding workflow principle was to create a one-stop-shop for their clients, where production, editing, graphics, sound design and searches on the custom 500,000-plus file music/sound effects database could be done under one roof.

At the heart of the design was the desire for an infrastructure in which signals and materials could be moved around with ease. The 1TB storage server from Dynamic Network Factory was central, creating a common sharing ground where engineering staff, operators and clients can transfer image or audio files, After Effects, Web postings, word documents, or any other type of data. The server acts as an effective intermediary between Windows, Mac and SGI machines, which may otherwise have had problems communicating properly.

The HD buzz

HD had been only a small portion of Creative Group's total business until it performed the post for the theatrical release, "Bowling for Columbine," by director Michael Moore. At that point, HD projects picked up considerably, giving the facility significant experience to draw off of. Besides being invaluable when specifying equipment for the HD linear editing suites in the new facility, this experience also helped guide the physical

your show matters

KCET Los Angeles
KLRU Austin
KQED San Francisco
MPTV Milwaukee
NETC Lincoln
WEDU Tampa
WIPR San Juan
WMHT Schenectady

"We test drove multiple digital audio consoles but the Euphonix Max Air console outperformed them all in regard to intuitiveness and value. It is truly a great console - easy to use and very well priced for the quality.

Lee Young – Director of Engineering, KQED"

Max Air at KQED

PBS is among the many TV stations and groups that have selected Euphonix to meet their broadcast audio needs. Euphonix is totally committed to providing the most effective and reliable audio mixing solutions for on-air and live-to-tape applications. We will do whatever it takes to get you on-air and keep you on-air with support, training, and technical expertise that is second to none.

The System 5 and Max Air models can be tailored to exactly meet your current and future production needs with a simple upgrade path and comprehensive features including surround, full integration with your facility router, automation connectiviity to external GPIs, and a modular I/O system. Most importantly, the consoles are easy to learn and operate in a fast paced on-air environment.

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and networking design of the HD rooms themselves and eased the incorporation of HD capability into the Discreet suites, which feature six flame and smoke Tezro-based systems that are SD/HD-capable.

To handle the increasingly diverse demands of HD, one of the two HD linear suites is equipped with a Sony MVS8000 switcher with eight channels of DME, while the other utilizes a Sony HDVS7000 switcher with two channels of DME. Both engage a Sony 9100 editor, with Snell & Wilcox and Leitch converters and a Panasonic UFC1800 format translator. High-quality sound was a priority in these suites, so Genelec 5.1 surround monitoring and Dolby DP-572 decoders were installed.

To assure consistency and maximum flexibility for booking time, all five SD linear suites are identically equipped, using a Sony DVS7000 switcher with two channels of DME, a Sony 9100 editor and Genelec stereo monitoring.

One of the more notable aspects of the equipment list lay in the three audio suites, which are identically equipped and fully functional for 5.1 surround. Taking into account the company's original focus on video, it put a strong emphasis on the resources dedicated to the audio section with the thinking that a powerful offering there would spark a commensurate increase in HD business.

Each suite runs Pro Tools HD, with 48 channels of I/O. Critical listening comes via an array of six Meyer HD1 monitors with high-quality mic preamps, including Manley VoxBox and Millennia STT-1. Mix-to-picture takes place while viewing an NEC 61in plasma display. In addition, an array of Dolby solutions are employed. A/D, D/A and distribution is by Bench-

Equipment List

- Adobe After Effects, Photoshop
- AJA I/O
- Autodesk 3dsmax, flint, smoke
- Avid Symphony, Adrenaline
- Chyron Duet, MAX CGs
- D&K MSD600M digital metering
- Genelec 5.1 monitors
- Graham-Patten DESAM 8000 console
- Leitch Juno 3800 converter
- Meyers HD1 monitors
- Panasonic
  - VTRs
  - UFC 1800 upconvertor
- Rorke 4 TB SAN
- Sony
  - MVS8000 switcher
  - HDVS7000 switcher
  - DVS7000 switcher
  - HDW-F500 HDCam
  - DigiBeta, DVCAM, IMX VTRs
- Tascam DA88, DA98
- Z-Systems 32x32 router

Design Team

Creative Group
- Joseph Avallone, president
- Charlie Suydam, chief engineer
- Joe Castellano, partner/editor
- Troy Krueger, senior sound designer

Fiskaa Engineering
- Thomas Fiskaa, consultant

Max Video
- John Durbeck, consultant

Rafferty Bros.
- Donnelly Mechanical

Sony SIC
- Eddie Son Ly, consultant
- Howard Dixon, consultant
- Andy Knierian, consultant

A Squared
- Andrew Thompson, architect

Sterling Sound
- Jim Maher, acoustic consultant

mark, combining with a Z-Systems 32x32 router to move all audio signals.

In light of the size and scope of the move, the technical glitches were minimal. Most notable among them included the fact that once the Sony HDS-X3700 and Klotz Vadis routers had been installed and connected, Creative Group found itself challenged by initial technical difficulties, including unexpected audio clicks, as well as control routing problems. Extensive troubleshooting revealed that the cause was inappropriate clock choice. By using a digital audio reference signal word clock, as opposed to a video reference, the team was able to solve what was otherwise an extremely confusing situation.

Above and beyond any difficulties that came with implementation of the technical plant at the new facility, the group encountered an even larger challenge on a logistical level — keeping the old facility running while building and transferring personnel and equipment to the new facility. The company accomplished this by using a combination of systems integrators instead of just one, which allowed it to maintain an aggressive schedule of moving all of the rooms over the course of 10 weeks.

As the company continues to expand its new facility, especially in terms of HD capability, the staff considers the move to be successful. Demand for HD services is healthy, and the audio suites are heavily booked not only for promo work, which is the mainstay of its business, but also for DVD mixing and production. Most important to the company leaders is the feeling that they have created an inviting atmosphere for some of the industry's top talent to do high-quality work in a wide variety of formats. **BE**

David Weiss is a New York City-based journalist and technology writer. He is the New York Metro editor for Mix *Magazine.*

Measurements for DTV

BY DON MARKLEY

Like it or not, DTV is not only coming, it has fully arrived. With essentially everyone operating a DTV facility at some level, it's now possible to get a good idea of how successfully the new medium is performing. We aren't talking about a good controlled test environment, but some general observations, primarily the result of a lot of antenna measurements and the subsequent comments.

DTV basics

The VSWR considerations on DTV antennas aren't much different than the requirements that have been standard for NTSC systems for years. For NTSC, the basic goals have been an antenna VSWR around 1.05 with a system VSWR of under 1.0:1 across the 6MHz. band. Emphasis was always placed on the visual carrier, aural carrier and color frequencies because those were where the greater amounts of energy existed in the transmitted signal and where the most effect would be observed in the received signal.

Reflected signals at or very near the visual carrier will result in a good old-fashioned ghost in the received signal. This is probably the most objectionable result of high VSWR as far as the viewer is concerned, which brings up another point that engineers are likely to forget. The purpose of all the tuning isn't just to make ideal meter readings in the transmitter building. The goal is the best possible signal quality for the viewers — distortion- and ghost-free to the fullest extent practical. Luckily, that goes along with the good meter readings — usually.

With regard to VSWR at color and aural frequencies, the result is distortion. That distortion shows up in the audio as degraded frequency response, increased harmonic distortion, increased cross talk and decreased separation in stereo systems. At color frequencies, the result varies but can result in "smearing" of color information. It's the old "the blue of the eyes isn't supposed to appear on the lips" syndrome. The entire thing gets worse when it is realized that the television transmitter really wants to see 50 + j0Ω across the television channel. As a general rule, the more the channel impedance varies from that amount, the greater the degradation of the transmitted signal. However, the worst problems occur around the three more critical frequencies.

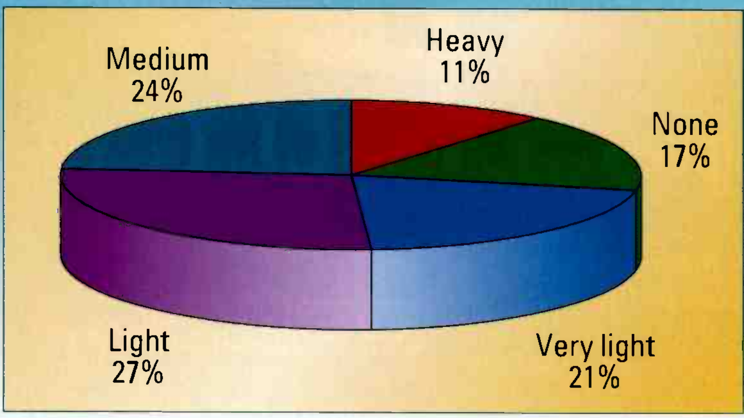
For DTV, there really isn't any small part of the channel where the power is significantly greater than the remainder of the channel and where significant information is carried. The information is essentially spread across the entire channel and not significantly susceptible to minor amplitude variations. Reflected signals show up at the receiver essentially the same as multipath signals would appear, that is, the same signal, reduced in amplitude, arriving slightly later in time. The current generation of DTV receivers will cope with multipath signals that are as large in amplitude as the direct path desired signal. Therefore, the total system can cope with minor reflections, even though larger amounts of VSWR may distort the signals so badly that the bit error rate (BER) is increased.

For DTV, the initial goals were to keep the antenna down to around 1.05:1 and the entire system under 1.1:1 across the channel. However, there is a significant amount of thought that DTV systems will perform quite adequately as long as the average value of VSWR is well below 1.1:1. In other words, some excursions slightly above 1.1:1 might be acceptable if the majority of the response across the channel is lower. As there is no critical frequency in the ATV signal, what were previously thought to be undesirable variations may not be as bad as originally feared.

FRAME GRAB A look at the consumer side of DTV

Percentage of American on-demand usage

One in ten Americans are heavy on-demand media consumers



SOURCE: Arbitron/Edison media research *www.arbitron.com/ www.edisonresearch.com*

Testing problems

More work needs to be done in this area involving real stations and on-air signals, not just simulations in the lab. There are a few problems involved in such testing. First, it requires taking a station off the air, detuning the antenna and taking measurements over a clean path — preferably short. Second, it is necessary to schedule the necessary engineers, riggers and equipment to do the tests. A third issue is getting someone to either pay the bills for all those people or getting them to simply absorb their costs in the interest of gaining knowledge.

So far, it has been difficult to meet all those problems at the same time, but it is being worked on. Until such research is completed and evaluated, the wise course is to attempt to meet the above criteria — that is, the antenna at or below 1.05 and the system at or below 1.1. This seems to result in good performance by the DTV transmitting system.

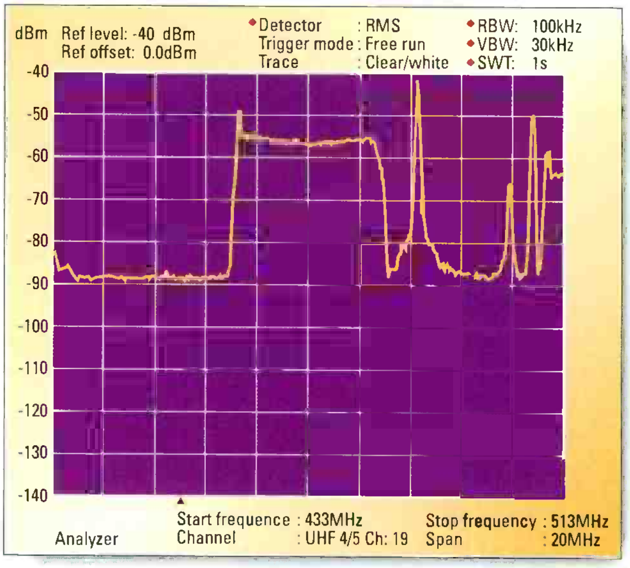


Figure 1. Spectrum analyzer display of adjacent TV channels, DTV channel 19 (center) and NTSC channel 20 (right). Note NTSC signal's visual, chroma and aural carrier components. Image courtesy the Freberg Engineering Company. A copy of John D. Freberg's NAB05 paper is available for purchase from the NAB publication office.

DTV diplexing

One desire of a lot of stations has been to diplex their DTV signal onto the same antenna as their NTSC signal when they are either first adjacent or they are only separated by a few channels. The separation by several channels is simplest to deal with. Unless the antenna was specifically designed for broadband operation, it won't work. Most NTSC UHF antennas are designed and tuned for a specific

channel. All the initial tuning work is done to optimize the antenna over 6MHz with the understanding that everything outside of that bandwidth may go to the bad place as far as the designers are concerned. As NTSC signals on adjacent channels were not allowed, no one really cared about out-of-channel impedance values.

If one is lucky, and the antenna isn't too old, diplexing on n±1 may be possible. Antenna designs in later years have tended to have a little better bandwidth that extended outside the channel a bit. To determine if this is the case, a network analyzer can be used to evaluate the input impedance of the antenna on the additional channel. This is done by looking at the antenna in the time domain mode over the additional desired channel. If the VSWR at the antenna is fairly low, it may be possible to add a fine matching section at the antenna to achieve satisfactory operation. Such operation may even be possible in systems with round, truncated or rectangular waveguides. The transitions to and from waveguide will often have to be redesigned to allow additional tuning, but such hardware is far cheaper than having to replace the entire antenna.

In any case, the only reasonable way to attempt such diplexing is to obtain the existing VSWR data on the desired channel and then go directly to the manufacturer. Other problems may exist that rule out any combining signals. For example, if the transmitting antenna is directional, what will the pattern look like on the new frequency? However, it has been shown that diplexing on single channel antennas can often be done by accepting some slight increase in VSWR on the DTV channel. Again, it required careful measurement, adjustment and coordination with the manufacturer.

This article has primarily been concerned with the effects of VSWR on analog and DTV signals. The measurement of the transmitter output regarding distortion, BER and other variables is a much broader category. Readers are advised to review the excellent articles that were presented in that area at the recent NAB conference. In particular, "Understanding DTV Transmission Measurements" by John D. Freberg is an easy read with a lot of valuable information. The paper can be found in the "Conference Proceedings," which are available from the NAB store. BE

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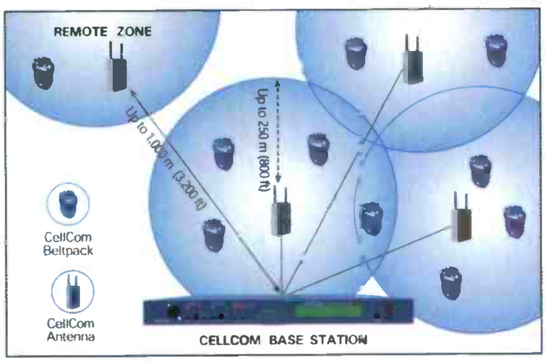
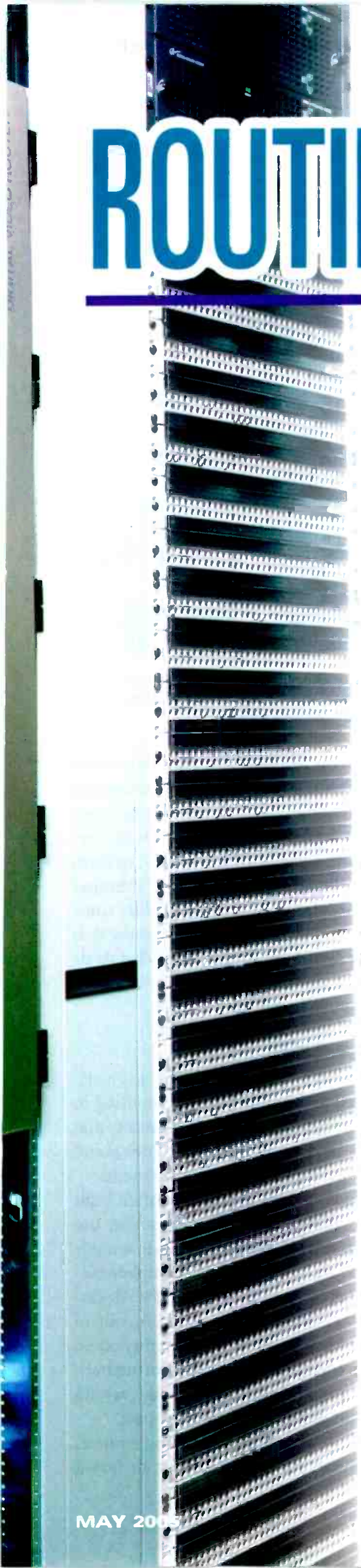
don_markley@primediabusiness.com


CellCom


REMOTE ZONE
Up to 1,000 m (3,200 ft)
Up to 250 m (800 ft)
CellCom Beltpack
CellCom Antenna
CELLCOM BASE STATION


TRINIX
DIGITAL VIDEO ROUT



ROUTING SWITCHERS

BY JOHN LUFF

Routing switchers are a key element of modern video facilities of all types and sizes. From single buss switchers to behemoths as large as 2048x1024 capable of switching one to many levels, these routers represent critical elements without which few facilities could operate. They provide many approaches to workflow and technical design, simplifying what would otherwise be far more complicated, and in some cases impossible. Thus, it is appropriate that we review the state of the art periodically.

Signal types

Analog routing switcher technology dates back at least four decades, and serial digital routing has been available since shortly after SMPTE and EBU published the specifications for the SDI interface known generically as SMPTE 259M. SMPTE 259M defines a copper interface on coax and includes specifications for levels, jitter, connector type (75Ω BNC) and other important data for equipment manufacturers. HDTV signals with a data rate of 1.485Gb/s are similarly defined in SMPTE 292M.

Another important signal to note are MPEG compressed signals, which are often carried over a DVB-ASI infrastructure at 270Mb/s. With a shorthand nomenclature of ASI, it has the same bit rate as SMPTE 259M, but is coded as NRZ, as opposed to SMPTE 259M, which is NRZ-inverted (NRZI). What is important is that NRZ signals are polarity sensitive. Most common digital hardware can pass ASI today, but caution is always wise when making that assumption.

SMPTE 310M defines a lower bit rate (19.3Mb/s or 38.6Mb/s) explicitly for carrying ATSC bit streams, which also can fit in many routing switchers. Together these standards, along with composite analog 525 and 625 NTSC and PAL, represent the majority of digital signals that end up being created or passed in a modern plant.

There are many other types of signals, most of which can be properly routed with today's multirate switchers. Even so, it is important to know exactly what types of signals your router will encounter so bandwidth requirements, connectors, format and signal conversion, and analog and digital factors can all be carefully considered before making a selection.

The audio bugaboo

With today's programming video, audio is no longer a second-rate signal, or as video engineers used to say, "The noise that accompanies the picture." Rather, audio is often equally as important as the image. Audio routing can be handled by embedding it in the SDI signal (up to 16 tracks in an HDTV signal) or by carrying it as a discrete signal. Both analog 600Ω audio and AES-EBU digital audio are common, with AES over coax as an unbalanced 1V signal or on 110Ω twisted pair interface when desired.

The ability to route signals like these obviously requires sophistication and care to insure the integrity of the signal. All signals should be switched synchronously if possible. So long as all signals are locked together, that is imminently doable. Video signals are switched on line 10, but AES signals must be sample aligned to make noiseless switching possible. Techniques, sometimes called soft switch for AES, are often employed, which perform a brief cross fade to avoid instantaneous impulse distortion in the reconstructed analog audio.

switching content

However, with today's increasingly complex audio mixes, simple XY switches may not be sufficient. This has lead some audio routing equipment manufacturers to develop time domain multiplexing technology. These routers offer interesting possibilities, including the ability to pull an AES pair apart and treat them as discrete mono signals, which can later be recombined or even mixed within the router. This is a powerful feature for several reasons, but when combined with an input circuit that allows for analog inputs, the implication is huge.

Such routers, available from Grass Valley, Leitch, NVISION, Pro-Bel and others, effectively allow a facility with both analog and digital audio interfaces to act as if it were all operating on one interconnection standard. Legacy hardware needn't use converters, multiple levels of routing, tie lines or other approaches. This can be quite effective as facilities transition from legacy analog to digital systems.

Embedded audio offers another way to simplify a routing structure. Large facilities, where audio and video are treated as a single program element, can simplify from multiple levels. There is, of course, a down side: The cost of embedding and de-embedding hardware necessary for some sources and destinations can offset part of the gain in cost efficiency a single level digital video router might offer. In addition, it is important to look at the total cross point count needed for each signal type. If only a handful of audio sources are needed with analog I/O, it might be best to embed. However, if a large amount of conversion hardware will be needed, it may well be cheaper to just buy a second level for the router. It's important that a thoughtful analysis be undertaken before making any decisions here.

Embedded audio offers another way to simplify a routing structure.

New video solutions

Similar to the above audio router designs, several manufacturers offer internal conversion of analog and digital signals in their video routers. In general, these SD video conversions are acceptable for monitoring needs. However, it is best to evaluate performance of these circuits to be sure that the quality of the internal conversion meets your monitoring needs. Some products may use less sophisticated conversion for both space and cost reasons. If high-quality conversion is needed, it may still be best to use external high-quality converters. Even so, this approach can have significant impact on monitoring, permitting the use of lower-cost monitors with analog inputs to view digital signals in a mixed format router.

Large systems made up of multiple frames usually require input distribution amplifiers. Though not unique, Grass Valley offers passive splitters and combiners with internal circuits that can recover the gain lost in the splitters. This is cost-effective and can be done as part of any installation by purchasing wide bandwidth RF components readily available from more than one manufacturer. Consider that this approach may be more reliable because fewer active components are needed.

Routers, like this one from Pro-Bel, offer the ability to handle analog and digital audio as one interconnected standard.

Optical and compressed signals

In a similar vein, some manufacturers have added optical I/O to their products. Optical interfaces allow for the use of much longer cables, especially for HD signals. For example, you could feed a remote secondary router in a system of managed tie lines without the need for external electrical-optical conversion hardware. In the future, we will likely see photonic routing, i.e., optical only, as a serious option for this industry. However, at this time, the cost of photonic routing may be too high for wide scale deployment.

At least two manufacturers are exploring adding compressed outputs to routing switchers, with IT Ethernet connections for trunking lightly compressed signals between islands. It is not clear how ubiquitous such a strategy might become, but it is worth keeping an eye on.

Reliability

Today's routers must be sophisticated and highly reliable, resulting in strategies for improving reliability that take into account real world needs and MTBF for individual components.

Today's large routers are often built on crosspoint architectures that use chip sets as large as 256x256 in a single module. The impact of a complete failure of such a module could be devastating. With so many circuits out of service at once, an entire facility could be rendered inoperative. Fortunately, the more likely failure modes would result in a much smaller impact.

However, when evaluating routers, consider the impact of a single board

failure. For instance, the impact would affect only eight sources if inputs are grouped eight to a card. If the input card supports 64 signals, a single board failure could affect 64 sources, representing a much larger impact. Careful assignments of inputs to distribute the risk across multiple boards and systems can help prevent a catastrophic impact.

Main and backup feeds should not go through the same electronics. NVISION, Utah Scientific and others offer hot spare modules, which can replace cross points and in some cases inputs. With both the main and backup feeds continuously monitored, such systems can detect failure and automatically switch between inputs. Fortunately, an argument can be made that even though the total number of circuits within a router may increase, by virtue of redundant electronics and monitoring circuits, the multiplicative effects of MTBF results in a system no more likely to experience signal failures than traditional designs.

Router control

Despite all the fancy monitoring and signal processing that routers may offer, operators see only a control panel. A decade ago most control systems connected using propri-

ROUTING 4:2:2 DIGITAL SIGNALS

ITU-R BT601 defines the picture coding standard, using the shorthand notation of 4:2:2. This represents the method used to sample the picture before being coded for transmission over SMPTE 259M. The intent of the shorthand is to describe the relative sampling rates for the Y, C_R and C_B samples, with Y being sampled at roughly four times the color subcarrier (actually 13.5MHz), and the color difference channels sampled at half that of the luminance (6.75MHz).

Readers are cautioned that 4:2:2 is also a nomenclature used in MPEG standards to denote a completely different concept related to the relative coding of Y, C in the horizontal direction, and C in the vertical direction. The net result is a data rate of 270Mb/s for either 525 or 625 pictures, an important fact for much of our technology today. SMPTE 292 defines a similar NRZI bit stream with similar 4:2:2 coding based on a sample rate of 74.25MHz. SMPTE 292 also defines an optical interface. The picture coding standards for HDTV are 296M for 720 line systems and SMPTE 274M for 1920x1080 systems.

etary, or at least broadcast-specific, communications over coax or multipin cable using low bit-rate asynchronous communications. Today, many routers rely on TCP/IP communications, facilitating interconnections using ubiquitous IT-based network structures.

Whether on a common switch fabric with other services, a segregated VLAN or a separate IP network reserved for routing control and status, this approach leverages inexpensive and robust bandwidth that can be extended easily across wide area networks as needed. This can add power and flexibility to a facility's workflow. In fact, new and enriching complexity becomes available because of the expanded bandwidth that is available to control new router functions.

The LDS Church Conference Center in Salt Lake City uses two interconnected NVISION 8256-Plus 256x256 expandable video routers.

Using IT technology facilitates graphical user interfaces and software panels that can reside on general-purpose computers. Although some manufacturers still use proprietary control busses for reasons that should not be ignored, be sure to explore the full range of options TCP/IP technology can provide. Compare the strengths and weaknesses carefully based on your particular application.

Finally, today's routers often use SNMP and proprietary schemes to become self-monitoring. A router can provide remote monitoring of its internal health and status, including temperature, power supply voltages, fan speeds and module failures, reporting all this and more back to a centralized control point. With system management software packages, engineers can be provided with a full complement of control, monitoring and logging features to keep tabs on what is really the backbone of most broadcast and recording facilities. BE

John Luff is senior vice president of business development at AZCAR.

DATA STORAGE'S GROWTH in broadcast engineering

BY Ron Quartararo

The IT world is rapidly changing the landscape of broadcasting. The fundamental change began with the ability to convert analog video into a well-organized digital package of bits and bytes. Though digital formats have existed for years (D1, D2, D3, Digital Betacam, etc), only recently have video packages become storable, manageable, and transferable files. This translates into much greater efficiency, both in the speeds at which video can be moved and the ways in which it can be manipulated.

The basic difference between data in the broadcast world and data in the traditional IT world is that this data is a broadcast engineer's lifeline. It is their product. It's the news packages, spots, promotions and programming, all of which depend on modern technology to deliver business value. If an e-mail server becomes disabled, a company and its employees are inconvenienced. If a video server becomes disabled, things could get very ugly, very fast!

Another basic distinction between video and data is the enormous size of video files. An uncompressed two-hour SD file could easily chew up several hundred gigabytes of storage. Storing files in uncompressed form requires massive storage capacity and creates significant challenges when it comes to transporting the content.

The digital age begins

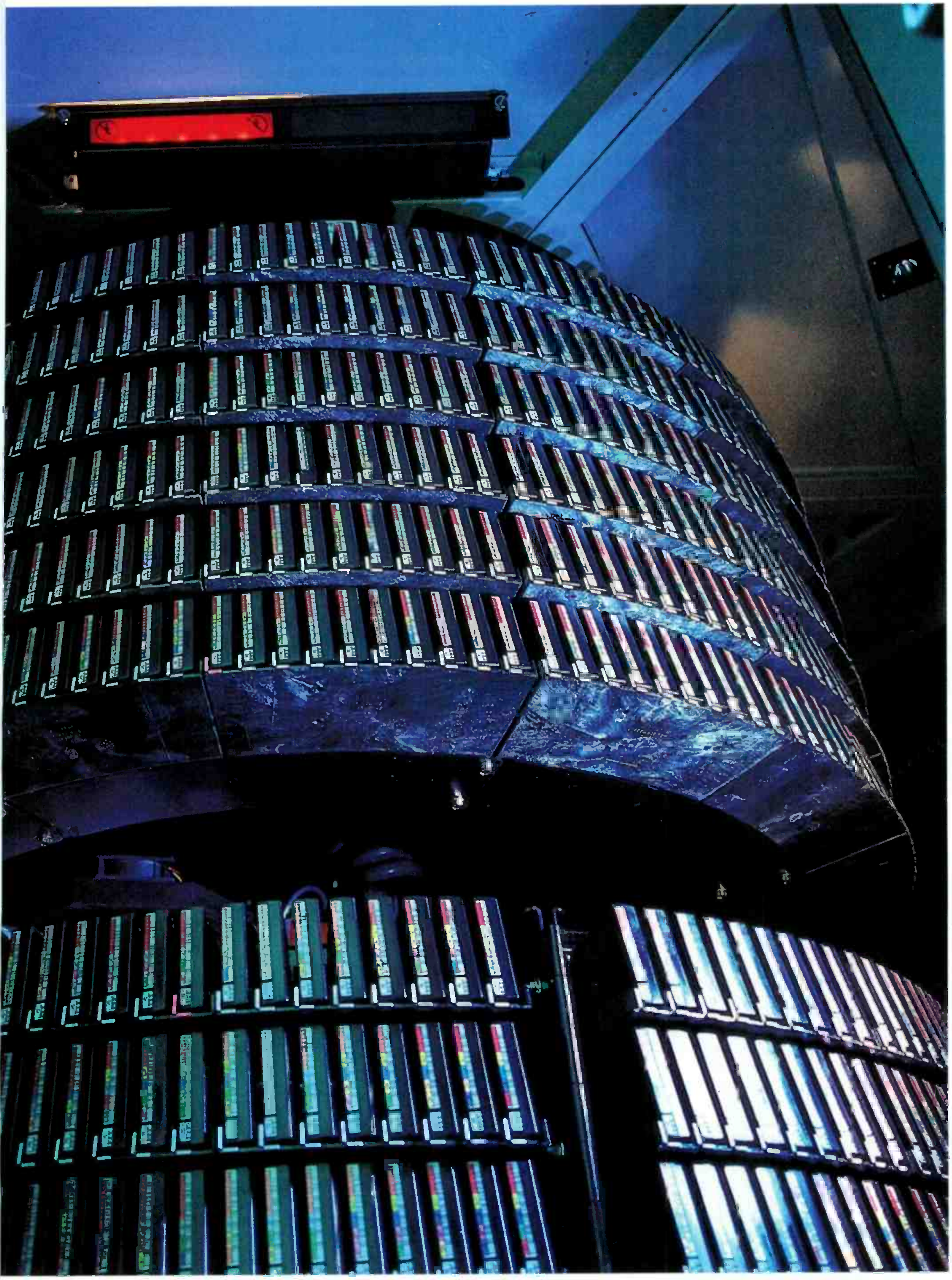
Before digital compression, video could only be transferred in real time. And while video could be routed around a facility digitally using serial digital interface, a one-hour program would still take an hour to transfer. Along came digital compression, and with it, greater efficiencies in transfer rates and storage.

Video post production was revolutionized in the late 1980s with the introduction of nonlinear editing — the ability to manipulate video content digitally with the kinds of tools that had previously changed the face of word processing and document publishing. Then, in the 1990s came the introduction of broadcast video servers — high-performance, highly reliable computers taking the place of VTRs. Both systems used digitally compressed video along with their own proprietary file systems, storage systems and video formats. While they increased productivity exponentially within their operation, rarely did they communicate with one another. The problem became interoperability: what to do with the data once the proprietary storage devices were full. Typically, the content was played back out to videotape where it sat on a shelf until needed. This meant the tape would need to be re-ingested or re-encoded back into the broadcast server if it was to be aired again or sent back to the NLE system if it needed to be edited or re-purposed.

Only recently have video packages become storable as files.

Managing digital

The issue then became, how does a broadcaster manage the growing storage needs of the new IT-based content it is accumulating? The answer came from traditional IT storage vendors, who pioneered the introduction of large robotically automated, tape-



based libraries capable of holding thousands of hours of content.

In 1986, one of these libraries could hold 120 terabytes via 6000 tape cartridge slots. Today, an automated tape library can hold 2.6 petabytes via 6500 slots, with throughput over 500Mb/s, enabling the storage of more than 100,000 hours of video at a hefty 50Mb/s in a single library.

Additionally, files can now be transferred at speeds of up to 10x real time. New tape drive technology will continue to push the envelope for density and throughput. This will have a greater impact as more broadcasters move to HD environments where storage and bandwidth requirements typically increase by a factor of six.

The process of taking an IT storage device and plugging it into a video server, however, was fraught with challenges.

Bearing archive management

The process of taking an IT storage device and plugging it into a video server, however, was fraught with challenges, including proprietary file systems, the need to communicate with automation systems and the need to transfer content from library to server and back again on demand. The solution was borne from a niche group of software vendors who developed middleware known as archive managers.

Archive managers solved this problem in several ways. First, they integrated with broadcast automation systems so that they could take commands from those systems when a request for content was made. As play/programming lists were created, automation systems made commands as content was deleted and online disk storage space became available. In addition, as new content was ingested into a video server, the automation system would be programmed to send a duplicate copy to the archive for future reference. This insured that aired content could simply be deleted with the master residing in the tape archive.

As archive systems developed, intermediate disk buffers would be added between the broadcast servers or NLE

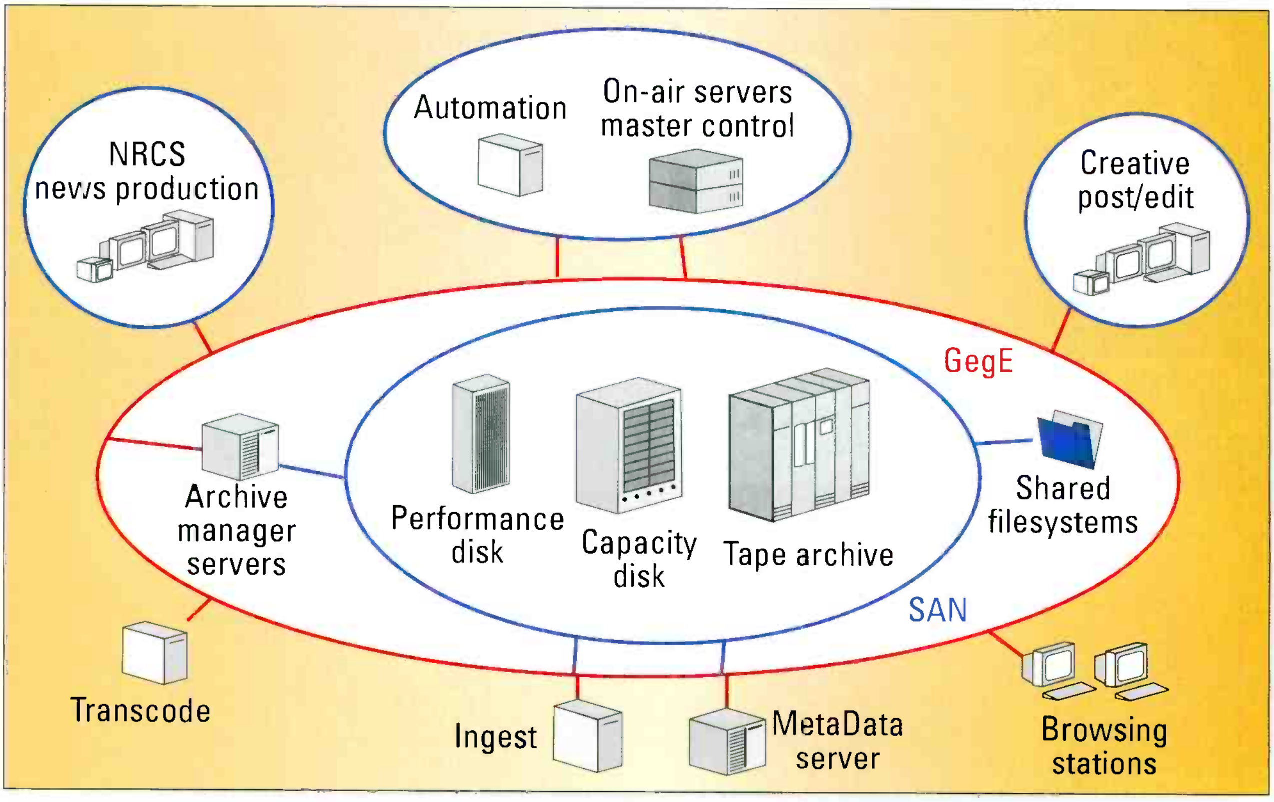


Figure 1. Digital content archive architectural overview

systems and the tape libraries. The purpose was to facilitate hierarchical storage management, now known as content lifecycle management. Content lifecycle management works by storing content needed for play out within X number of days on the server. Content frequently re-aired is stored on intermediate, less expensive disk.

And all remaining content is housed in the tape library representing the ultimate content repository.

Extending this model even further, archive managers can now manage a remote disaster recovery (DR) site where a second tape library sits with a duplicate set of all video files. If an accident were to occur in the primary location, the archive manager can pull content from the DR library and move it across a WAN to the primary broadcast facility for play out or re-editing.

The ability to store massive amounts of content and transfer it into and out of storage libraries has enabled the move toward a tapeless environment.

Changing storage

The ability to store massive amounts of content and transfer it into and out of storage libraries has enabled the move toward a tapeless environment. Because digital tape libraries and disk subsystems are agnostic in terms of the video formats supported, multiple formats can be stored and recalled from the same storage device, creating immediate efficiencies. Over time, the cost of maintaining and repairing VTRs for each tape format will diminish as more content is ingested and digitally archived.

There is also a favorable trade-off between storing content on expensive videotape versus much more economic and faster data tape. Today, an LTO3 tape can hold approximately 30 hours of DV 25 video at an estimated street cost of about $5 per hour, or roughly 70 hours of MPEG-2 10Mb/s at a cost of about $2 per hour. In addition, while there are certainly significant cost savings in media, there are also clear savings in terms of the overall hardware footprint. Imagine how much floor space a 200,000-hour DV 25 news library would take up versus a 60sq-ft data tape library.

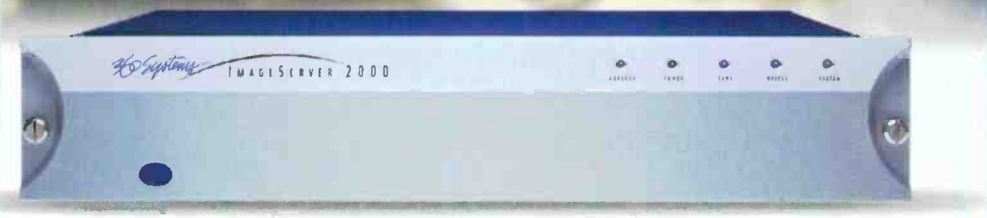
There are also clear productivity gains to be realized, such as no longer having to re-ingest content that has been played out to tape because the disk on the server is full. Also, content often needs to be shared between servers playing out different channels, which means continually re-ingesting the same files. A centralized digital content archive solves these problems by maintaining content in digital form, eliminating the need for re-ingestion.

Some of these issues have been addressed by the broadcast vendors who have steadily added more disk storage to their servers and created shared file systems and SANs for their post and news operations. Even so, digital content creation and distribution has outpaced that fix and, therefore, the need for tape libraries — large and small — continues to grow. An important factor is the cost ratio of disk vs. tape: 100 to 1. That's a lot of money.

In 2005, it is now common to see digital infrastructures being built from the ground up for television stations as well as larger cable and broadcast networks. Central to these facilities is their respective digital storage and archiving infrastructures. As HD continues to proliferate, this need will increase. So too will the need for broadcast engineers and IT professionals to peacefully co-exist and become more immersed in each other's pursuits. There is a growing need for professionals that understand IT as well as broadcast engineering — both in the technical sense, but just as importantly, in the business sense. Clearly, the need to understand and embrace data storage and digital content management is integral to this new paradigm. BE

There is a growing need for professionals to understand IT as well as broadcast engineering ... in the business sense.

Ron Quartararo is the Broadcast/Media & Entertainment manager for StorageTek.



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SPECIAL REPORT:

HDTV lens design:

Management of light transmission

By Larry Thorpe and Gordon Tubbs

Broadcast engineers have a comfortable familiarity with electronic transmission. They understand related issues of channel transmission losses, interferences, reflections, ghosts and other aberrations. The optical lens system, meanwhile, is in some sense a microcosm of the larger electronic transmission system, with many direct parallels. The optical system caters to a much higher frequency portion of the electromagnetic spectrum than does its radio/television cousin.

The multi-element lens is all about light transmission. As outlined in previous papers, skillful management of Modulation Transfer Function (MTF) is an inherent part of contemporary lens design. So too, management of light transmission through two dozen or more optical elements is an equally complex task. In that context, two aspects of that transmission system are of primary importance:

- The amount of light that emanates from the output optical port of the lens is a measure of the sensitivity (or optical speed) of the lens in question.
- The shaping of the spectral response of that light in its passage through the many elements comprising the lens system has a direct bearing on the color gamut reproduction capability of the lens/camera system.

The optical lens system is in some sense a microcosm of the larger electronic transmission system, with many direct parallels.

Challenges in HDTV studio lens design

In the management of the light flux passing through the lens optical system that forms the final image for presentation to the camera sensors, there are four core issues relating to light transmission that are inextricably intertwined. They are:

1) *Transmittance* of the lens — the maximum amount of light the lens can transmit.

2) *Aperture control* — the calibrated iris mechanism to precisely control the degree of light passed by the lens.

3) *Relative light distribution* — the inescapable limitation of an optical system. It curtails the degree of light transmitted at the peripheries of the image relative to that at the center of the lens optical system.

4) *Spectral transmittance* of the lens — the shaping of the light transmission between the blue and red wavelength extremities, a significant contributor to the colorimetric performance of the lens/camera system.

We will begin with the efficiency of the light transmission through the complex multi-element optical system that constitutes the studio lens.

The characteristic shown in Figure 1 is a typical HD studio lens specification. It shows the spectral transmittance characteristic of an HD lens that exhibits an average transmittance of 82 percent. For a lens comprising in excess of 30 separate optical elements, this is an impressively high number. Powerful computer-aided design, advanced optical element materials and exotic multilayer optical coatings on each of those elements contribute to this efficiency of light transmission.

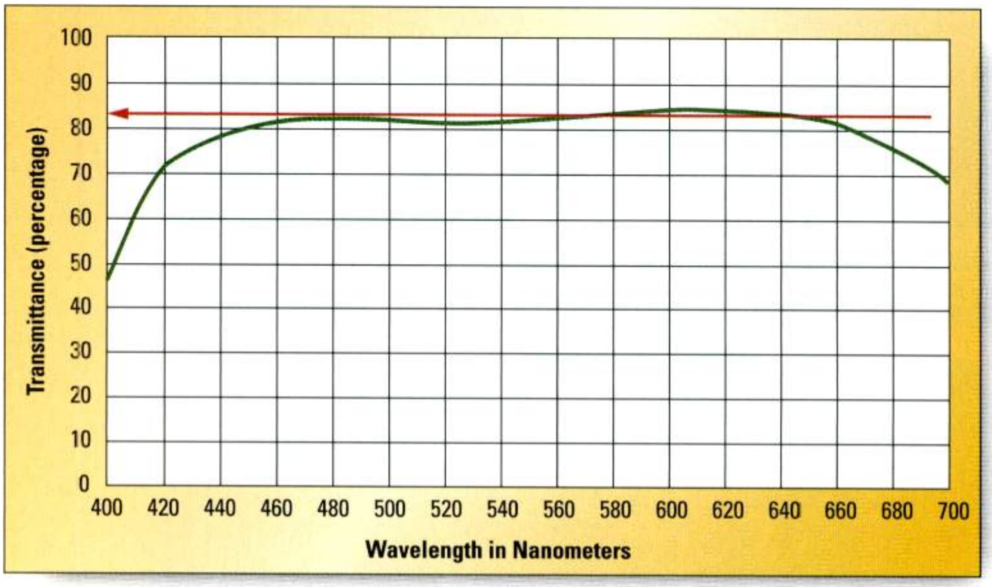

Figure 1. Spectral transmittance of a typical HD studio lens, showing both the amount of light that reaches the output port and the attendant careful shaping of the spectral response

A traditional optical measure that defines image brightness at the center of the lens output optical port is derived from the ratio of the lens' effective aperture (D) to the focal length (f). This quotient D/f is called the aperture ratio.

Aperture: Both geometric and photometric

The studio lens has a built-in mechanical iris system that facilitates remote control of the amount of light transmitted by the lens. This is a mechanically variable opening, or aperture, that alters the diameter of the group of light rays passing through the lens. It allows a known degree of control over the brightness of the image being formed at the lens output port. This important operational control is calibrated to facilitate the precise management of the light transmitted by the lens to the HD camera image sensors. This, in turn, facilitates the management of the lens/camera dynamic range when imaging scenes that have enormous contrast ranges.

In the traditional television or video world, these calibration steps are termed F-numbers, and the nature of this control is known as a geometric aperture system. The actual value of the F-number is the inverse of the aperture ratio — in other words, f/D.

> **The true merit of the F-number calibration is its accurate depiction of *changes* in light level for a given lens system.**

Geometric aperture

The F-number expresses the optical speed of the lens on the assumption that 100 percent of the incident white light is transmitted through the lens. This is impossible in the real world of lens design, as indicated in Figure 1. For video shooting, this is of no great importance. The true merit of the F-number calibration is its accurate depiction of *changes* in light level for a given lens system. F-number values are expressed as a geometrical series

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starting at one with a common ratio of square root of two as follows:

1.0, 1.4, 2.0, 2.8, 4.0, 5.6, 8.0, 16.0, 22.0, 32.0

Each doubling of the number indicates a precise halving of the previous amount of light exiting the lens-output port. This relationship has long served the broadcast studio operation well. It is important to remember, however, that given that the spectral transmittance of lenses made by different lens manufactures invariably will *not* be the same, any two lenses having the same F-number may actually have different optical speeds. This needs to be carefully accounted for in side-by-side tests between different lenses using appropriate light meters.

Photometric aperture

The moviemaking world has always been cognizant of the true amount of light passed by the lens, and lenses for film cameras have long employed an alternate calibration system known as photometric aperture. The new cine lenses for digital cinematography cameras also employ this method of calibration — one that is described by T-numbers. T-number values take into account the reality that 100 percent of the incident light is not passed through the lens. The values carefully factor in the transmission efficiency percentage of the lens. Therefore, any two lenses having the same T-number *will* have identical optical speed. A later paper will explain this calibration in cine lenses for digital motion picture cameras.

T-number values take into account the reality that 100 percent of the incident light is not passed through the lens.

Relative light distribution

Relative light distribution is a familiar term to optical designers, and it refers to a physical phenomenon that is sometimes called peripheral illumination. The specified lens F-number indicates the brightness of a lens at the center of the optical axis. The brightness at the edge of the image is invariably less (due to the unavoidable vagaries of optical physics) and is expressed as a percentage of the center illumination. This peripheral illumination is affected by (a) the Cosine 4th Power Law and (b) optical vignetting.

The Cosine 4th Power Law, familiar to optical designers, states that the rate of light fall-off in peripheral areas of the image (peripheral illumination) increases as the angle of view increases. This is true even for a perfect lens, if such could be built. The amount of this fall-off is proportional to the cosine of the angle (at which the light rays are entering with respect to the optical axis of the lens) raised to the fourth power.

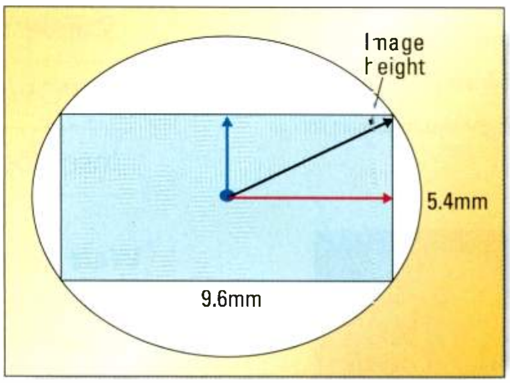


Figure 2. Shows how the light distribution is measured relative to the light level at picture center on a 2/3in HDTV optical image

Vignetting is caused by the physical fact that the lens mechanical barrel

eclipses part of the peripheral light, which causes a 360-degree darkening of the edges of the optical image. This can be eliminated if the diameter of the lens optics is sufficiently increased. Accordingly, it is less a challenge with the larger studio lens than it might be with the necessarily smaller diameter portable EFP/ENG lenses. Vignetting also decreases as the lens is stopped down. This also improves the relative light distribution problem.

Relative light distribution is expressed as a percentage ratio between the center image brightness and that of off-axis points. This is traditionally specified along the radial termed image height, as shown in Figure 2. A typical published specification for this optical brightness distribution is shown in Figure 3.

As is clear from Figure 3, the light-distribution shortfall is more acute when the lens operates at maximum aperture (with iris wide open). The light distribution characteristic will alter when the focal length is changed, and the effect will increase toward the wide-angle setting.

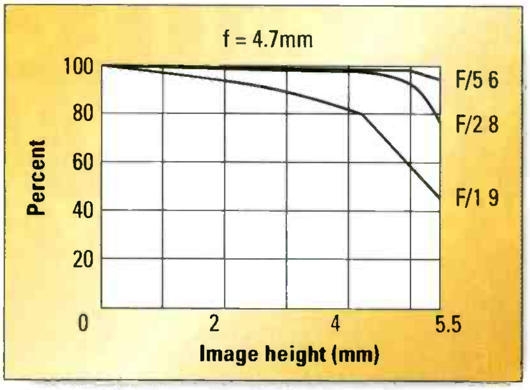


Figure 3. The relative light distribution behavior for a typical HDTV studio lens at one specific focal length

Spectral response and color reproduction

The goal of the lens-design team is to achieve a lens design that transmits the maximum amount of light, or, in other words, to minimize the attenuation of the amount of light entering the front port of the lens as this flux passes through all 30-plus optical elements. At the same time, those many elements that comprise the lens system must be optimized so that they work in concert to shape the spectral response of the output light flux, predetermining the color reproduction of the system. It does this by closely correlating with the separately specified spectral response of the camera prism beam splitter and the spectral response of the camera's CCD (or CMOS) imager.

The lens spectral transmittance curve is designed in close collaboration with the major camera manufacturers because it must accommodate

The goal of the lens-design team is to achieve a lens design that transmits the maximum amount of light.

subtle variations in their respective shaping of their camera optical beam-splitter characteristics, the spectral response of their individual CCD (or CMOS) imagers (and associated IR cutoff filters), and the final design of their respective linear matrix circuits, which ensures that the overall lens/camera system colorimetric response meets the published standards of

SMPTE 274M/296M and ITU 709 — as outlined in Figure 4.

While attempting to meet the nominal specifications contained in the standards, which, incidentally, have no published tolerances, the lens designer also seeks to implement a spectral characteristic that will maximize the total range of colors that can be reproduced by the lens/camera imaging system. The proprietary design techniques used by each optical manufacturer will invariably produce variances in this color gamut capability — and this can only be evaluated by careful subjective testing (a topic of a later paper).

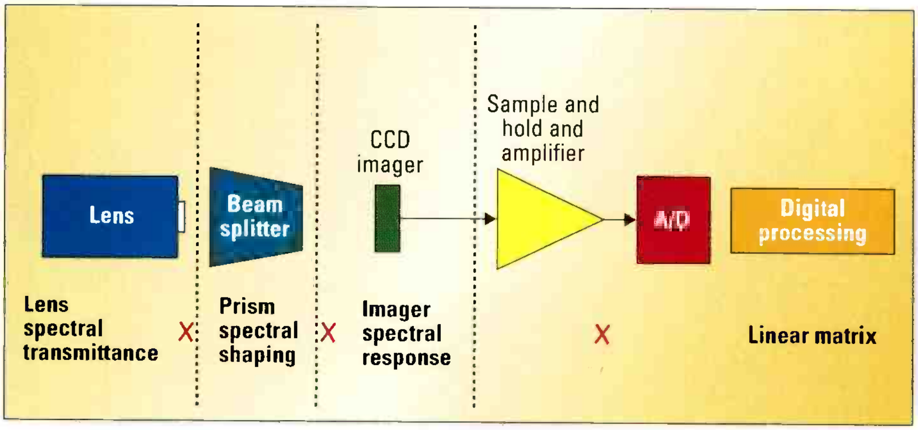


Figure 4. The four core elements of the HD lens/camera system that determine the colorimetry prescribed in the ITU-709 and SMPTE 274M/296M HDTV production standards

Summary

As stated in our second paper in this series, the contemporary lens is an engineering marvel. Our previous papers exposed the challenge posed to the optical designer in the all-important domain of preserving high image sharpness while the camera operator is exercising zoom, iris, and focus operational controls.

At the same time, as these factors are being optimized, the designer is preoccupied with eking out every degree of transmission efficiency possible to raise the optical sensitivity of the lens. And, at the same time, the careful shaping of that spectral transmission characteristic must be crafted in sync with the separate design optimizations being wrought by different associated camera makers.

But, the challenge does not end there. We'll see in the next paper, while managing all of these design variables, the designer must simultaneously wrestle with an extensive list of optical aberrations and distortions that also vary — sometimes in a quite contrary manner — when the lens operational controls are exercised. BE

Larry Thorpe is the national marketing executive and Gordon Tubbs is the assistant director of the Canon Broadcast & Communications Division.

Testing
Audio-Technica's AT2020

BY ROB FRITTS

Audio-Technica sent its latest microphone, the AT2020, to the folks at *Broadcast Engineering*, who asked me to give it a thorough testing. My findings: This mic stands up to the sounds of rampant guitars, concrete-cracking drum beats, piercing screams of aggression and passionate lyrics.

On stage

The first test was in a bar on stage with multiple sound sources. I placed the AT2020 at center stage for the lead vocal of a punk rock band. The mic, with its high sound pressure levels (SPL), handling capability (144dB) and wide dynamic range (124dB, 1kHz at maximum SPL), never showed any signs of overloading, even when the lead vocalist was screaming out the lyrics.

Isolation was key in getting a good sounding vocal, and the microphone has a fixed cardioid polar pattern that provided ample isolation of erroneous sounds. The AT2020 is a side-address condenser microphone and showed slight fluctuations in frequency response (5kHz) when the performer moved side-to-side. However, the performer had to work the mic in a tight space to avoid those slight variations.

He was also mainly 3in to 4in away from the microphone. I noticed a big drop in amplitude starting at 6kHz when the performer backed off of the mic 9in to 12in. This microphone performs best between 2in and 6in and directly in front of the capsule.

In the studio

The second test was in a studio environment while recording narration for a National Geographic documentary. The narrator had a low, deep voice with great presence at 5kHz. The mic handled this presence in a natural-sounding way, but I was a little disappointed in the overall low-frequency response. The sound was not the warm, deep sound that I know the narrator possesses. By no means did the mic sound harsh or too bright. It was good enough to use in this application, but it just did not have that rich, warm sound of more expensive and larger diaphragm mics.

The mic handled proximity effect of low frequencies well — even when the narrator popped his Ps. I was impressed with the mic's performance when recording a sibilant-sounding source. The sibilance was not harsh but rather smooth. The mic showed a slight bump in amplitude at about 9kHz, which helped project the voice.

Next to strings

The microphone's lack of warmth showed problems when trying to record an acoustic guitar. I placed the microphone 6in away from the base of an acoustic guitar and recorded a performance in an isolated studio. This mic is a better vocal, narrator or radio microphone than an acoustic guitar microphone. However, it sounded good when placed 6in in front of a Marshall guitar amp. The microphone handled the high SPLs well and sounded natural and flat between 300Hz and 5kHz.

Against a competitor

For kicks, I tested the AT2020 against a Neumann U87 condenser microphone using a male and a female narrator. With the male voice, each mic showed good presence and a natural sound. The Neumann U87, as I expected, had a warmer-sounding characteristic than the AT2020.

Audio-Technica's AT2020 features a custom-engineered low-mass diaphragm, providing extended frequency response.

On a female voice, the AT2020 represented the sound naturally and handled the sibilance smoothly, not harsh or too bright sounding.

A good mic for the project/studio market

With the AT2020's low price in relationship to that of the Neumann, it's an exceptional value for a smooth, natural-sounding instrument, with all the performance advantages of a high-quality studio microphone. It seems to fit perfectly in the project/home studio market. **BE**

Rob Fritts is the senior mixer for Henninger Digital Audio.

Video broadcasting goes to the races

BY DWIGHT CRUMB

The broadcast engineering world tends to think of broadcast as being sent only to the home. However, there are many other applications that use the same technology to broadcast audio and video to other venues. Horse racing has done this for years, and there is an extensive network between racetracks and off-track betting locations around the world.

Magna Entertainment recently introduced a new way for fans to enjoy horse races. The system, the Horse Wizard, is a simplified wagering machine that allows the beginning horseplayer to wager on races from multiple venues around the world on Vegas-style gaming consoles. The selection of races is handled by the system's network operations center (NOC).

The NOC consists of a multichannel master control and wagering control terminal (*i.e.*, a gaming console). For each program stream, the master control operator monitors multiple available tracks, selects wagering information for the game console and switches audio and video for the associated track. To keep the action moving, specially produced race packages are inserted into programs when the timing between races allows.

Providing live broadcast feeds to racetracks around the world requires the same technology as a TV station, but without the transmitter. Live feeds and interstitials play on the monitors above the casino floor.

Planning

In late July 2004, representatives of Magna's broadcasting division met with Distinctive Video Engineering to discuss the feasibility of the planned betting system to be on-air Sept. 3. Originally, it was planned that switching program material between venues could be achieved through remote channel selection of the horseplayer's console. However, it was determined that the associated break-up glitch would not be the professional look that was desired. Distinctive Video Engineering presented the concept of a multichannel NOC using Quartz master control switchers and an Omneon video server for interstitial content.

The NOC was built at the Santa Anita Park in Arcadia, CA, which is also home to HRTV, Magna's in-house horse racing channel, because most of the required signals already existed there. A small storage room under the grandstand and adjacent to the broadcast center was selected. During the first week of August, it was cleaned out, the old floor was jack hammered, a new concrete floor was poured and the walls were painted. Equipment was ordered on Aug. 4. High Tech Furnishing quickly built and installed the NOC's 11-bay-wide console in time for installation of the system on Aug. 16, concurrent with the installation of the sprinkler system and air conditioning. The system came online on time on Sept. 3.

The NOC is designed for up to three operators to work together, each han-

dling two program streams. Each operator is seated in front of three bays. The left bay is one program stream, the center bay is for server control and the third bay is the other program stream. Between each set of three bays is a shared quality control station. As budget was a concern, it was decided to go with 9in black-and-white monitors for track previewing. Each operator has six routable monitors across the top row of his set of three bays. The lower row has a pair of 9in color monitors for preview and program for stream one, two black-and-white monitors for the server channels and a pair of 9in color monitors for preview and program for stream two. The four monitors located in the bays between operators have four fixed IRD feeds, as these are shared.

The operators each handle two live program streams sourced from the Omneon servers and real-time races.

Signal flow and challenges

The NOC needed to be able to generate multiple programming streams due to variations in gaming regulations at the different wagering sites throughout the world that preclude some sites from receiving some tracks. The design was for up to six program streams, with three being implemented in 2004. Those three feeds currently go to Santa Anita Park; Golden Gate Fields in Albany, CA; Laurel Park in Laurel, MD; and Magna Racino in Ebreichsdorf, Austria.

Showing a new race every five minutes is not always possible, so to keep the action moving, Magna wanted the capability to add interstitial content. Another requirement of this system was to supply clean, professional transitions between the various venues.

> Showing a new race every five minutes is not always possible, so ... Magna wanted the capability to add interstitial content.

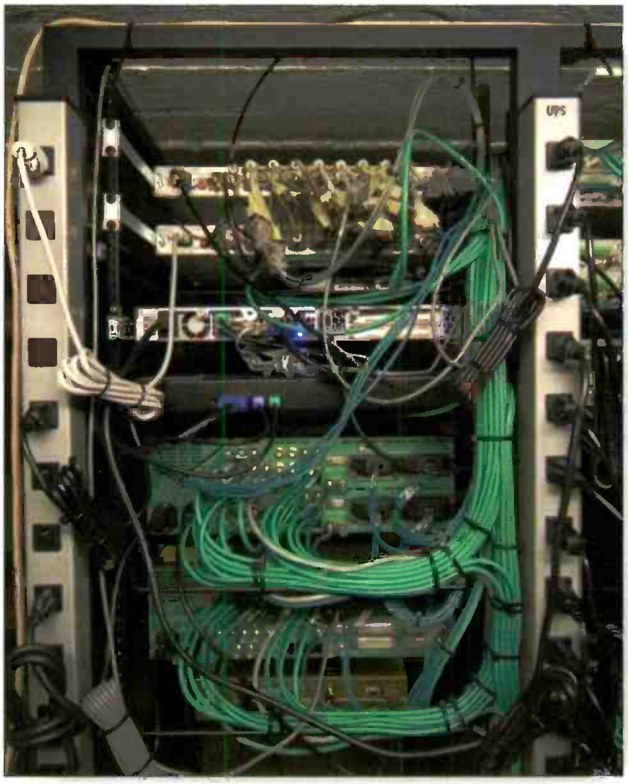
The video signal flow starts with the IRD to import the program material from a racing venue. The output is an analog signal that feeds into the existing HRTV analog satellite router. This Grass Valley Venus router needed to be increased in size from 48x32 to 64x64 to accommodate the additional requirements. For each program stream, two outputs from the satellite router feed into a pair of Leitch DPS-575 frame syncs that not only synchronize the incoming feed but also convert it to embedded SD-SDI.

The outputs from the frame syncs feed into a Quartz 32x32 Topaz SD router, which functions as the cross-point matrix for the designed six channels of Quartz master control processors. Other SDI devices, including the Omneon server, are also connected to the Topaz router. Outputs from the router feed the master control switchers, the server-ingest channels and the two quality control stations.

One challenge was the two-stage routing required. This routing process needed to be totally transparent to the operator. The control system performs this function flawlessly. When the operator selects a particular satellite feed on preset, the control system first determines which of the two frame syncs for that channel is not on-air. It then controls the Venus router to route the associated IRD's analog signal to the correct frame sync. The control system then switches the selected frame sync through the Topaz router to the preset input on the master control switcher. When it is time for that signal to be used, the operator triggers the switcher and it performs the transition to put the new racetrack on air.

One other positive feature of the switcher is its ability to assign any of the sources on either the 64x64 Venus and/or the 32x32 Topaz router to any of the input selection buttons on the QMC control panel. The electronic legend pushbuttons automatically update to keep the operator informed as to what sources are assigned to that button. Reassignment of any button is a simple and intuitive matter of just a few key strokes.

The Omneon server has 78 hours of storage at 10Mb/s. It is configured with two MIP 1003a MediaPorts for ingest and one MIP 3006 MultiPort,



One of the racks during construction with the router control interfaces and video over IP encoders above the Quartz equipment.

with six channel playout. Inputs to the MIP 1003a are both routable. The MIP 3006 was chosen to allow for the designed six channels of programming. The system uses three of these channels, allowing spare capacity for HRTV to experiment with. The horse racing channel is currently using this spare capacity for inserting commercials into its own program stream.

One of the Omneon server's many strong points is its ability to be expanded while in service. There are ongoing

The system uses three of the six channels, allowing spare capacity for HRTV to experiment with.

discussions to take advantage of this feature and to enlarge the server as HRTV grows.

Another challenge in the project was creating a cost-effective method of distributing the different program streams to the venues. At first, satellite distribution was used, but a lower-cost solution was needed.

Currently, both Golden Gate Field and Laurel Park are receiving MPEG-2 compressed video. As these races are fast moving, live sporting events, latency was an issue. It was determined that at least a 2.5Mb/s data rate was required, which is why dual T1 lines were chosen. Each T1 line can carry up to a 1.544Mb/s data stream. The two T1 line are switched together and connected to the encoding and decoding equipment over an ethernet connection. Another advantage of the T1 lines are their bidirectional nature. The company is looking into using the return bandwidth to get clean feeds from these tracks for HRTV.

As with all television facilities, the only constant is change. In the past 12 years, Magna's broadcast center has grown from a leased seasonal facility to a permanent, year-round, daily broadcast operation with multiple program streams for on-track, off-track and in-home viewing. **BE**

Dwight Crumb is the systems engineer for Distinctive Video Engineering.

Using AutoNorm for dialogue normalization

BY TIM CARROLL

Loudness issues have plagued television broadcast for decades, and digital television is turning out to be no different. Luckily, the audio format specified by the ATSC is AC-3, better known as Dolby Digital. And it has some built-in features that, when used properly, can help to alleviate the problems.

Unfortunately, these features often sit dormant and unused. The results are clearly audible in most television markets, and many broadcasters note a dramatic increase in complaints. Now is the time to get this problem back on track, and we present an innovative way to do just that.

Reviewing the standard

Basically, the Dolby Digital signal is divided into two sets of data: compressed audio data and informational/control data called metadata. The metadata describes the audio signals it rides with, reporting such things as the number of audio channels present (audio coding mode), how to re-mix the audio if more channels are present than speakers to reproduce them (downmix coefficients), user selectable dynamic range control and the loudness of the program (dialogue level or dialnorm).

When developing the Dolby Digital system, Dolby Laboratories determined that dialogue is the anchor of most programs and is what most viewers use to judge the loudness of that program. Yes, cannon shots or car crashes may be loud, but they are not sustained events.

Dialogue, on the other hand, occurs throughout most of a typical program, and is, therefore, a logical choice for a loudness anchor. This is done by making a long-term A-weighted measurement of typical dialogue, that is sections without screaming or whispering, and referencing this value to full-scale digital.

All decoders use the difference between the measured value and the internal reference level of Dolby Digital (-31dBFS) to directly control a 1dB per step attenuator. For example, if a typical motion picture is measured and found to have an average dialogue level of -31dBFS, then the difference from this measurement and the internal reference level is zero and the decoders will apply no attenuation.

If a typical sitcom has a dialogue level of -21dBFS, then the decoder will apply 10dB of attenuation. It should be obvious that this can be a useful technique for matching the loudness of one program with the next. And if done correctly, it would result in all the channels matching each other. Imagine that!

In these somewhat early days of multichannel audio in DTV, transporting metadata is certainly becoming more commonplace, but by no means is it a risk-free process.

How loud is it?

Measuring dialogue loudness has always been a challenging process. Initially it involved expensive meters, cross-conversion charts, and plenty of patience and time to get a single correct value. This quickly led to the parameter being ignored in many cases. Dolby Laboratories developed the LM100 broadcast loudness meter to make this an easy and almost automatic procedure. While this meter does its job well, it still requires operator intervention to apply the results to the system.

Automatic normalization

Taking this pioneering work to the next logical step, Linear Acoustic developed AutoNorm, a real-time method to automatically apply these measurements to audio signals and compressed bit streams. The dialogue level parameter generated by the meter is further processed, and then inserted into precompressed Dolby Digital streams, metadata streams, and eventually Dolby E and HD-SDI streams. The initial release is with the StreamStacker platform, which already allows for multiplexing and splicing Dolby Digital streams and frame synchronizes all of these streams to a local plant reference.

The LA-5124 AutoNorm demultiplexer and Bitstream Splicer are the DTV station side of the StreamStacker system and have a serial connection that interfaces directly with the serial port of the LM100. As the meter is measuring the compressed Dolby Digital stream, the dialogue levels are reported to the StreamStacker, which processes them and inserts them into the outgoing bit stream. Several parameters can be adjusted, which help to weight the incoming dialogue level values if desired and protect the bit stream in case of loss of the values due to connection or measurement failure. (See Figure 1.)

Why is this unique?

Classic attempts to control program loudness have all relied upon control-

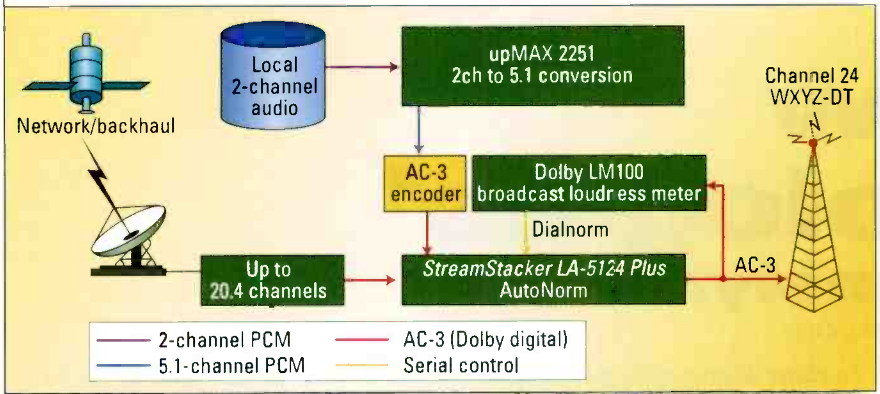


Figure 1. Shown here is AutoNorm as it might be implemented at a typical DTV station. Note that this shows such options as local audio being upmixed, and splicing between network and local AC-3 (Dolby Digital) streams.

ling the peak-to-average ratio of programs, and therefore reducing their dynamic range. While this works well in many cases, it has two drawbacks. First, the dynamic range of the program is sacrificed to protect against the occasional offending loud commercial or program. And second, it is not reversible.

The Dolby Digital system includes a dynamic range system that defaults to applying dynamic range control but allows users who desire more or a full dynamic range to scale their decoders. Loudness matching is tied more closely to the dialogue level parameter, and this is not adjustable by the consumer. The dynamic range processing system in Dolby Digital relies on a properly set dialogue level. Otherwise, inappropriate amounts (i.e., too little or too much) will be generated and the system becomes ineffective.

Catch it in transmission

In these somewhat early days of multichannel audio in DTV, transporting metadata is certainly becoming more commonplace, but by no means is it a risk-free process. Many things can cause metadata to go missing or be incorrect, with the result being inappropriate audio delivered to consumers. Since the final catch point remains the transmission area of the terrestrial, cable or satellite broadcaster, it seems to be the most logical place to check and, if necessary, regenerate proper dialogue level values.

Now that measurement of the dialogue level is a straightforward process, we bring the circle to a close by allowing the measured values to be inserted into pre-encoded Dolby Digital streams at the point of transmission. This will allow the long-term loudness of a television station to be automatically adjusted just before the signal is sent on to consumers.

While dynamic range control might still be necessary in certain situations, such as controlling the instantaneous loudness of locally inserted commercials, the original dynamic range of normal programming will be preserved and loudness kept even. Several television stations in major markets have these systems on the air, and the long-standing problems of loudness are on their way to a permanent resting place in history. **BE**

Tim Carroll is the president of Linear Acoustic and the former product manager for the Professional Audio Division at Dolby Laboratories.

Morrow Technologies' spectrum analyzer

BY JOHN MORROW AND DEBBIE MUCCIOLO

It's breaking news. Your ENG truck pulls up, and the camera man jumps out to capture the action. The technician raises the mast and lines up the shot. The link is established, and you're feeding live signal. The competition powers up their transmitter, and your feed to the station drops off. Unlikely?

With the move to digital COFDM transmissions in ENG, this scenario is all too likely. While COFDM is designed to work well in multipath environments, interference can affect signal levels.

COFDM signals are susceptible to the cliff effect and to oversaturation; both result in the failure of the receive chain to produce a useable signal. The cliff effect refers to the drop off in reception resulting from marginal signal levels. When analog signals degrade, the picture quality degrades with an increase of sparkles or snow. However, digital signals lack the corresponding degradation of picture quality. When the signal drops below the minimum threshold, the digital picture simply and abruptly disappears. Conversely, oversaturation occurs when the signal level exceeds the maximum threshold. This causes excessive intermodulation or side band re-growth, preventing the receive chain from decoding the signal.

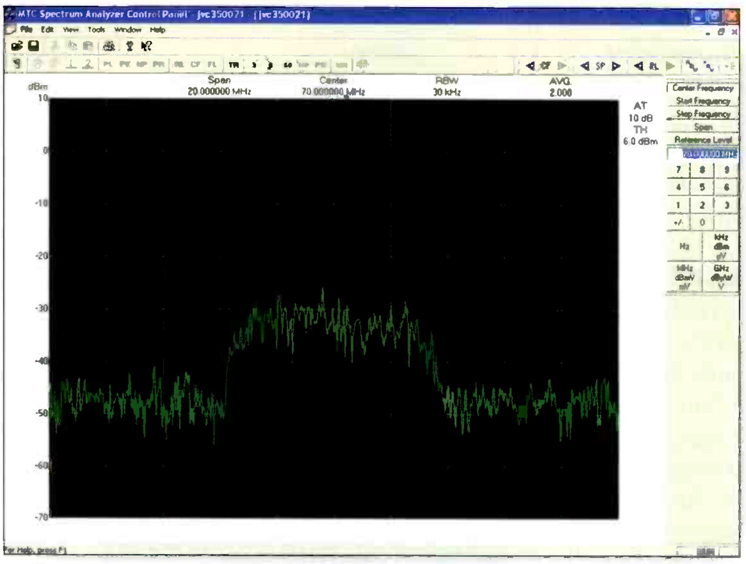


Figure 1. Carrier-to-noise = 16dB

In either situation, the picture quality does not give any indication of the proximity of the signal to the relative threshold until it's too late.

Antenna alignment is critical, and traditional alignment methods are no longer practical. In the analog world, technicians using a TV monitor and waveform monitor easily align, transmit and receive antennas. In the digital world, the picture is either perfect or simply not present. Using an analog signal to establish the link and then switching to digital can make antenna alignment faster, but it does not address how close the signal is to the threshold of the receiver. Is it right at the edge, ready to drop off? And what do you do when your ENG truck is completely digital?

The key to effectively managing COFDM signals lies in the use of a spectrum analyzer at the central receive site.

What about BER?

Bit error rate (BER) and modulation error ratio (MER) can indicate a signal's proximity to the threshold. BER refers to the number of bits that must be corrected by the receiver over a period of time. BER significantly increases when a signal approaches the threshold. Unfortunately, BER only identifies the problem when the threshold is near.

MER is a ratio computed to anticipate system performance. MER increases in proportion to signal degradation or oversaturation, providing warning that the threshold is approaching. BER and MER are relative measures based on already established links. They do not provide useful information when trying to establish a link or when trying to identify the cause of a problem.

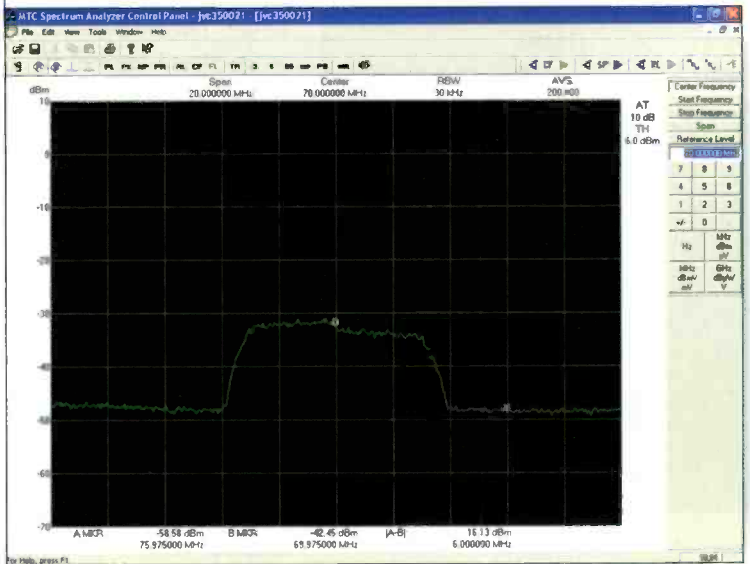


Figure 2. Averaged, with markers

Using a spectrum analyzer to view saturation

Saturation of the receiver is also clearly visible on a spectrum analyzer. Figure 3 shows a COFDM signal with sideband regrowth. Note the increased noise level at the edges of the carrier, resulting in a sloped rather than a flat noise floor. Monitoring a signal's carrier-to-noise and power level provides a technician with conclusive information to assess antenna alignment.

The spectrum analyzer can also be used to identify interference. Prior to establishing a link, the analyzer will show the presence of any signals that may cause interference. If the interference occurs after the link has been established, the technician should see changes in the signal, which vary depending on the source of interference. Proactive monitoring gives a technician the opportunity to take corrective action before the interference causes the signal to drop.

Proactive monitoring and quantifiable measurement

The key to effectively managing COFDM signals lies in the use of a spectrum analyzer at the central receive site. This allows measurement of the signal's power level and the carrier-to-noise ratio, ensuring optimal antenna alignment and reception power. When measuring carrier-to-noise, use of the averaging function will provide an accurate, quantifiable figure. Set a marker at the peak of the signal, and set another marker in the noise. The delta between the two markers is displayed at the bottom of the spectrum analyzer screen. Figure 1 shows a signal with a 16dB carrier-to-noise ratio. Figure 2 shows that same signal, averaged, with the markers clearly indicated.

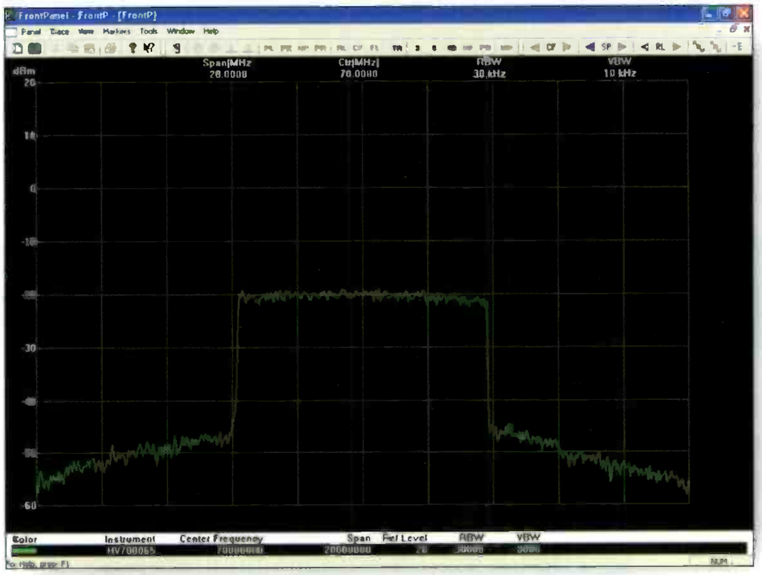


Figure 3. Sideband re-growth

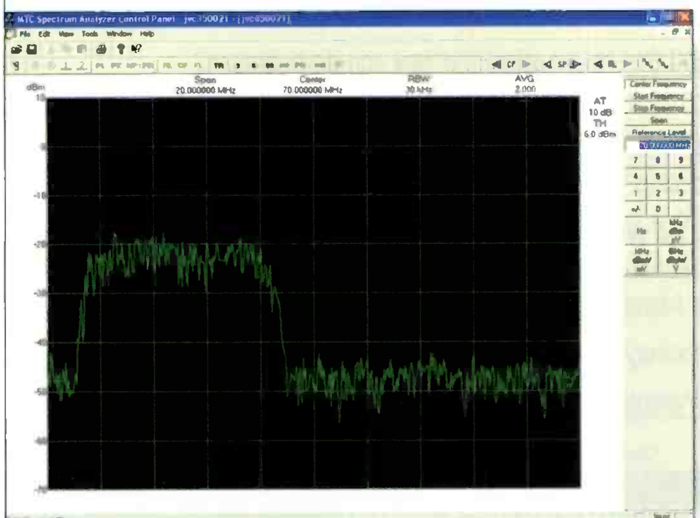


Figure 4. 65MHz center frequency

The use of offsets is a common practice in ENG transmissions. Say a field team setting up a link is unaware of the previous use of an offset. Monitoring the receiver's IF signal with a spectrum analyzer will reveal the offset. Illustrated in Figures 4 and 5 (on page 96) are two spectral traces displaying an offset of 5MHz. The spectrum analyzer clearly displays the center of the signal at 65MHz (Figure 4) instead of 70MHz (Figure 5), indicating the use of a 5MHz offset.

Remote connectivity is the key

A spectrum analyzer is the only reliable tool for quickly diagnosing and eliminating digital RF problems. However, traditional spectrum analyzers are expensive and are designed for use in manned receive sites. Because many central receive sites are in isolated locations, the use of a spectrum analyzer would seem impractical. Even with an inexpensive, scaled-down model, a spectrum analyzer in this application would necessitate the ability to access and control it remotely.

Fortunately, Morrow Technologies has developed the VC70BMS, a real-time, remote access spectrum analysis tool designed specifically for use in ENG operations. This analyzer is physically small in size and is engineered for more rugged environments. It has full functionality, and it can tap into the 70MHz IF output of the central receiver. The analyzer is accessed and controlled remotely from the station's transmission center or other network operations center. (See Figure 6.)

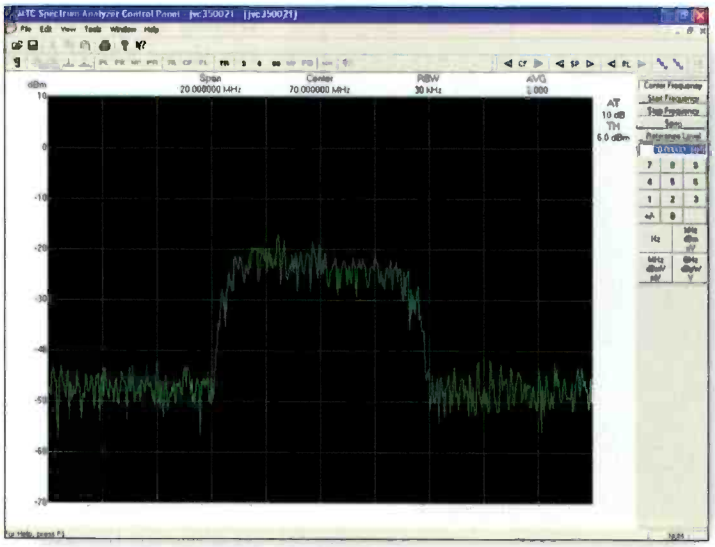


Figure 5. 70MHz center frequency

While traditional spectrum analyzers are designed to cover a broad range of frequencies, the VC70BMS has a focused 60MHz to 80MHz frequency range, thus eliminating additional circuitry and inherent cost.

The analyzer features Virtual Front Panel software that allows any authorized PC to access the remote unit. The software has all the control and display functionality of a tradi-

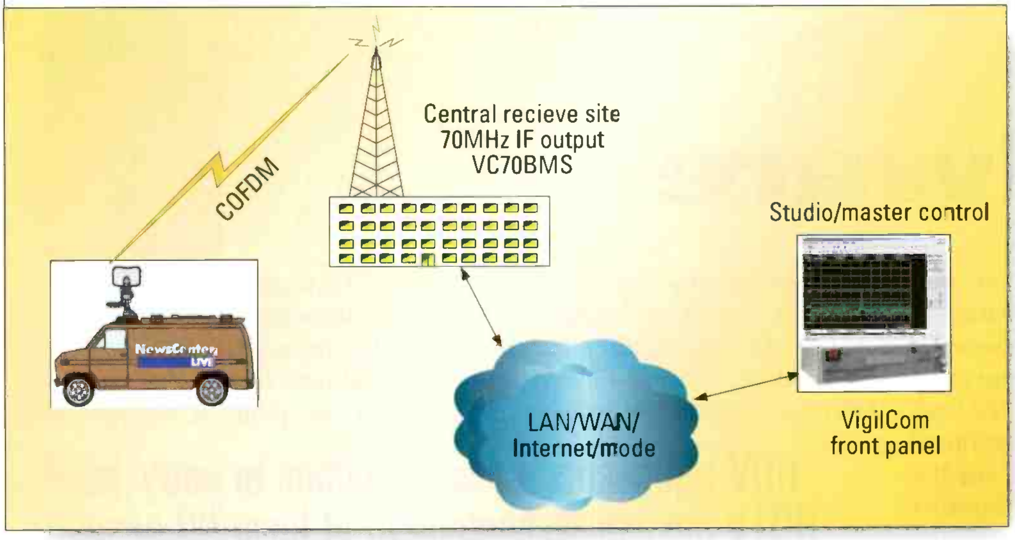


Figure 6. Configuration for remote monitoring of the central receive site

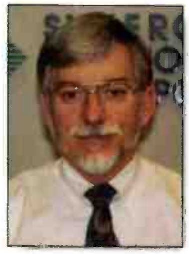
tional spectrum analyzer such as resolution bandwidth, video bandwidth and markers. The software can simultaneously display spectral traces from multiple units, allowing monitoring of multiple receive antennas or multiple receive sites. Multiple users can simultaneously view the same receive site from PCs in a station's transmission area, the engineering offices and anywhere else the software is installed. An engineer from home can assist a technician troubleshooting a problem. When installed on a PC in the ENG truck, users can gain remote access with a cell phone.

The analyzer is a self-contained unit with a built-in PC, eliminating the need for additional equipment, software and systems integration. It can be accessed by a variety of communication methods, including dial-up, LAN, Internet and wireless — all easily configured via the VFP. Simply install the analyzer by connecting it to the receiver's 70MHz output, power and communications outlet. The analyzer is available in a compact 10in x 8.75in x 2.312in model weighing under 5lb or a 1RU 19in rack-mount model, making remote deployment a breeze.

The transition to digital ENG necessitates changes not only to transmit and receive hardware but also to the tools and methods used to monitor and maintain signal quality. Historically, the TV monitor approach has been the de facto industry standard for analog transmissions. The remote spectrum analyzer will become the new standard for monitoring and control in the digital domain. BE

John Morrow is CEO and Debbie Mucciolo is project manager of Morrow Technologies.

HDTV hardware



BY JOHN LUFF

The title of this column is particularly apropos to the subject of HDTV hardware, for developments over several years have begun to turn HDTV into a real business. The "Technology in Transition" column is all about change, and this year's NAB gave plenty of evidence that HDTV is indeed in transition.

Over the last 10-plus years, we have seen several generations of HDTV hardware shown in private and public forums and often purchased in such low volumes that it must have seemed more a science project than a business intended to sustain itself. Not long ago, HDTV cameras cost $250,000 and more, a lens cost nearly $200,000, and a single VTR tacked on $360,000. A reel of tape cost $1000 for the first uncompressed HDTV recorder from Sony (circa 1994).

The MPEG solution

Something had to change if HDTV was to become a reality in the marketplace. Early projections said a station would need $30 million to build an HDTV infrastructure — a number that certainly precluded station profits!

The enabling change was compression, then called "bit-rate reduction." MPEG-2 could deliver HDTV in 20Mb/s instead of the 1.5Gb/s required for uncompressed signals. Recording and transmission became technically feasible, and that has changed everything. NAB this year marked the introduction of the HDV consumer and professional format endorsed by multiple manufacturers. Not much bigger than a conventional 525/625 camcorder, in fact smaller than a single image orthicon of barely 40 years ago, HDV represents a cost reduction in entry-level HDTV system technology of at least 99 percent from a decade ago. Nonlinear HDTV editing can be done for less than $20,000. HDTV switchers cost about the same as their SD-only equivalents in the 1990s.

HDV represents a cost reduction in entry-level HDTV system technology of at least 99 percent from a decade ago.

The miniaturization of HDTV technology has a lot to do with the trends. ASIC's and programmable logic have replaced complex multicomponent systems. Software has replaced hardware as the long lead time item in the development of new products, but allowed hardware designed with sufficient processing bandwidth to evolve as new code is released.

What defines the shift in the professional marketplace is a series of developments in the last three years that make HDTV economically practical for production and emission. Until perhaps three years ago, high-end HDTV switching and digital effects were just plain ridiculously expensive — $1 million for a practical production system, more than double the cost of SD-only. Today there are several manufacturers offering high-end capability in HDTV systems at a premium of around 30 percent over SD-only systems that are similarly equipped. Snell & Wilcox introduced a production switcher (shipped this year) that does both SD and HD at the same time. This kind of innovation would not have been possible a few years ago, but drives new applications and markets.

With HDV and similar cameras readily available in both 1080i and 720p from several manufacturers this year, HDTV news production at the local

With HDV and similar cameras available in both 720p and 1080i, such as Sony's HDV camcorder shown here, broadcasters will find HDTV news production at the local level attractive.

level might well be attractive to some broadcasters. There is no cost penalty of any consequence. That kind of change makes innovation by programming professionals much more likely. A decade ago, who would have thought HDTV editing on a laptop would be possible when an hour of recording media cost half of the cost of a laptop?

Lower conversion costs

An important element in all of this is the reduction in the cost of conversion between HD and SD formats. Early converters were half-rack or more, but now the functions of scaling and aspect ratio conversion can be done on a single card run by a wall wart and unceremoniously hung in the back of a rack as a black box hidden and forgotten. Four rack units can hold up to 15 converters now. I/O options include fiber for long-distance transport of the high bit rates needed.

The rest of the infrastructure all exists. Early HD routing cost $250,000 for 32x32. Now a 16x16 router costs barely $9000, and a full 128x128 frame costs under half of what 32x32 cost in 1997. Indeed, multirate routing is hardly an extravagance today, but rather a proper hedge for the future even if considering an SD-only project today. Routing is indicative of where the industry seems to be going. Why build or buy two different flavors of anything if one will cover both?

What's next?

With this kind of watershed change, what happens next is hard to predict. Consumer interest in HDTV has finally begun to show as more than a statistical curiosity. That interest has spawned new display technologies, as well as production techniques intended to satisfy both 4:3 and 16:9 audiences. Few barriers remain in providing the rich and full experience that consumers expect. With HD DVD expected late this year, it is reasonable to predict further consumer uptake.

While HDTV equipment and applications will continue to mature over the next few years, it seems all but certain that it will not be long before manufacturers essentially stop building products that support SD-only use. The cost penalties are dropping like a stone in a well, and the capabilities no longer produce compromises. Introductions like HDV are not evolutionary; they are revolutionary, for they challenge the view of the state-of-the-art for technologists and users alike. This could be a very interesting year indeed. **BE**

John Luff is senior vice president of business development at AZCAR.

SEND Send questions and comments to: john_luff@primediabusiness.com.

VIRTUAL ROBOTICS PEDESTAL

Shotoku TP-64VR: A lightweight, two-stage manual pedestal designed to be used with a virtual system; high-resolution encoders, which are mounted on the wheels and column, provide precise real-time camera position data of X, Y, height and pedestal base angle to the Serial Position Interface (SPI); provides reliable and accurate high-speed data.

949-754-9005; *www.shotoku.tv*

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+33 477 90 78 00; *www.angenieux.com*

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203-972-3199; *www.quantel.com*

UNIVERSAL ENCODER

Scopus Network Technologies UE-9120: Encodes two MPEG-2 channels simultaneously; advanced multiplexing capabilities include encoder cascading and save external multiplexing; integrates analog cue tone detection and DPI Cue Tone insertion (SCTE-35) to eliminate the need for an external Cue Tone detection device; provides IP output as a standard feature in addition to ASI.

609-987-8090; *www.scopus.net*

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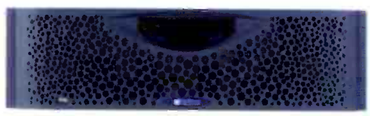

SINGLE-CHANNEL CHARACTER GENERATOR

Pixel Power Clarity300: Is available with three different software profiles; internal video clip player provides uncompressed 4:2:2:4 recording and playback from an internal disk array of up to four hours; storage can be expanded externally; can playback and record up to four audio channels; can be expanded to offer video clip playback and dual 2-D live squeezeback capability.

954-943-2026; *www.pixelpower.com*

MPEG IMX CAMCORDER

Sony MSW-970: Captures high picture quality using MPEG-2 4:2:2P@ML 50Mb/s I-frame compression; features three-chip 2/3in type Sony Power HAD EX CCDs; has 14-bit A/D Conversion and Advanced Digital Signal Processing (ADSP); records audio in either 20- or 16-bit resolution; LSI achieves a low-power consumption of 27W; remotely control camera settings and basic VTR functions.

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www.sony.com/professional

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Panasonic AJ-SPC700: Uses P2 storage; combines a 2/3in 520,000-pixel IT 3-CCD camera with 60 fields interlace recording in 25Mb/s DVCPRO/DV and 50Mb/s 4:2:2 DVCPRO50 format on a P2 card; switch between 4:3 and 16:9 aspect ratios; features three recording modes, a built-in memo microphone and a shot marker indication on video clips; has five P2 card slots, providing up to 160 minutes record capacity at DVCPRO and 80 minutes in DVCPRO50 with 8GB P2 cards.

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www.panasonic.com/broadcast

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Grass Valley LDK 4000: Supports 1080i or 720p production; features low-power consumption and Grass Valley's HD Dynamic Pixel Management (HD-DPM) image-sensor technology; includes a camera head, a base station and an HD triax cable adapter; choose between an 2in or 5in viewfinder.

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859-371-5533; *www.leitch.com*

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Miranda DV-Bridge CAM: Decodes 25Mb/s DV stream to digital video; supports DV, DVCAM and DVCPRO formats; SDI output features embedded audio and time code (DVITC); digital audio outputs lock at 48KHz; has four-pin and six-pin IEEE 1394 ports; supports 32kHz, 44.1kHz and 48kHz DV audio sample rates.

514-333-1772; *www.miranda.com*

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Avid DNxchange: Encode HD-SDI signals from cameras, switchers, routers and decks to Avid DNxHD media; once material is encoded, HD media can be moved over the existing SD-SDI infrastructures within a facility; converts DNxHD media into uncompressed HD files and outputs the media to any device with an HD-SDI interface.

800-949-2843; *www.avid.com*

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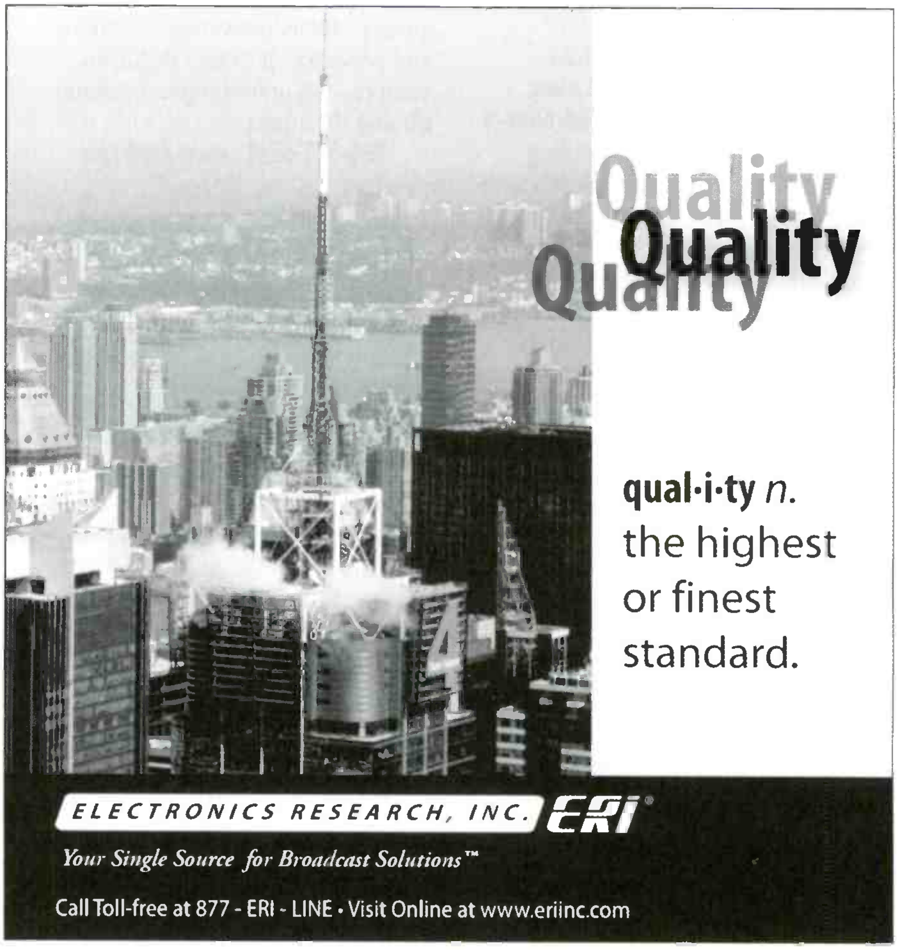
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Help Wanted

Senior Maintenance Engineer-Production & Maintenance

MPT has an opening for a Senior Maintenance Engineer. Duties will include repairs and maintenance on broadcast equipment and systems. We require a degree in electrical engineering or equivalent combination of education and experience, and three (3) years broadcast maintenance experience, to include digital video and audio experience. Working knowledge of television station operations preferred. Excellent State of Maryland benefits package. Salary $42,840 to $48,450.

Please send resume and cover letter, including position title, to:

Maryland Public Television
Human Resources Department
11767 Owings Mills Blvd.
Owings Mills, MD 21117
dblum@mpt.org

EOE

ENGINEERING MAINTENANCE TECHNICIAN

We are seeking a broadcast professional with a balance of experience between broadcast TV and computer (IT) maintenance. Successful candidate will have demonstrated knowledge of computer systems, networks, video servers, and station automation. Position requires a minimum of 5 years experience in broadcast television with extensive knowledge of and experience maintaining analog and digital video-audio systems, switchers, cameras and VTRs.

Send resume & cover letter (no calls) to:

James D. Gilbert
Director of Engineering, WPVI-TV
4100 City Ave., Suite 800
Philadelphia, PA 19131
Fax 215-581-4515
james.d.gilbert @abc.com

EOE

TRANSMITTER SUPERVISOR

Maintain proper operation of transmitters and equipment primarily at transmitter sites located in Salisbury and Annapolis, MD. May be required to travel to other sites throughout Maryland. Must be available to work nights, weekends and holidays for emergency calls. We require a degree in electrical engineering, or equivalent combination of education and experience; at least five years broadcast transmission maintenance experience, including digital transmission; two years supervisory experience. Excellent State of Maryland benefits package. Salary $49,980 to $56,355.

Submit resume and cover letter to:

Human Resources Department
Maryland Public Television
11767 Owings Mills Blvd.
Owings Mills, MD 21117
Fax: 410-581-4382
dblum@mpt.org

EOE

Help Wanted

Director of Broadcast Services & Engineering Alabama Public Television (APT)

APT, a statewide public television network located in Birmingham, AL, operates 9 transmitter sites with 18 transmitters, over 2200 miles of two-way digital microwave and a satellite distribution network. APT is also licensee of public radio station WLRH in Huntsville.

APT is seeking a dynamic and energetic leader with a minimum of 15 years of experience in broadcast delivery systems, supervision of engineers and master control personnel. This position will be involved in grant applications, budget development and forecasting, writing equipment bid specifications, tower lease negotiations as well as day- today operations. Must be knowledgeable of RF transmission digital and analog technology as well as automation/monitoring and control systems.

This is a State of Alabama Merit System position.
To apply for this position, please contact
Tracey Orr,
APT Personnel Manager
(205) 451-0134
or email torr@aptv.org.

Operations Manager

Media General Broadcast Group www.mgbg.comWCBD-TVWCBD-TV2 in beautiful Charleston, SC is seeking a Operations Manager. Responsilities include supervise the maintenance of all technical equipment, hiring and train maintenance, IT and Master Control staff. Maintain accurate programming, maintenance, and transmitter operating logs. Prepare and operate within a budget. Candidates need 3-5 years experience maintaining television systems, including audio/video systems and computers. M/F/V/D Drug Screen.

Send resume to HR Dept.
210 W. Coleman Blvd.
Mt. Pleasant, SC 29464
or email to hr@wcbd.com
or fax to 843-216-4871

Skycam, LLC is seeking a fulltime EIC to join our team of professionals providing fantastic aerial shots with our Skycam 4 point and LX 2 point camera systems. EIC must be mechanically inclined, have live broadcast, fiber optic, electronics repair and computer hardware experience, an understanding of basic computer software operations and be willing to travel extensively. Robotics experience a huge plus. Candidate must be a quick study and easily grasp complex electro/mechanical systems. The work is hard and the rewards are great. Not interested in fulltime? We are also seeking progressive thinking freelancers.

Please send resume to
Roy Patton
Skycam, LLC
6120 S. Yale Ave.
Tulsa, Ok. 74136

Help Wanted

ASSISTANT CHIEF ENGINEER

WISN-TV, a Hearst-Argyle television station and ABC affiliate, is looking for an Assistant Chief Engineer with drive, ambition and dedication to quality control of local news production and day-to-day engineering operations. The candidate must have an engineering degree or equivalent experience and a minimum of five-years broadcast engineering experience; or an equivalent combination of education, training and experience to meet the requisites of the job. Applicants must have a knowledge of LAN's, WANs and computer networking in general. A solid engineering and broadcast perspective is required with knowledge of digital studio systems. We are looking for a person with a positive, news-oriented team attitude with some skills in business management, accounting, and human relations.

Priority will be given to the applicant with previous experience in electronics maintenance, project management, RF engineering and previous technical management. A valid driver's license is required.

Fax resume to: 414-342-2657
E-mail: www.tcoleman@hearst.com
or mail to:
Tony Coleman,
Director of Engineering, WISN-TV
P O Box 402
Milwaukee, WI 53201

EOE

SignaSys
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SIGNASYS is seeking motivated, experienced, customer-oriented Engineering professionals to join our team. If your passion is cutting edge technology in a creative, fast-moving environment, stop! Immediately send your resume!

Ideal candidates should have working technical knowledge of broadcast audio/video equipment, connections, & related environments. Experience should reflect five years technical & three years experience commissioning projects with demonstrated ability to deliver on time.

SignaSys is looking for someone who fits well with the values of the existing management team: creative, honorable & an unwavering determination to succeed.

Immediately send your resume to rebecca.lampkin@signasys.com in San Jose, CA.
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Repetitive messages

BY PAUL MCGOLDRICK

We live in an era of spin, constantly being told the same thing from multiple sources. TV stations broadcast taxpayer-paid messages to pass on political propaganda while posing as independent news. Civil servants declare political scare mongering on the hold phase of department telephone help lines. What is going on?

Advertising gurus have said over the years — and my experience absolutely confirms it — that it requires between 10 and 20 exposures of a message for a customer to accept it. That doesn't mean that there is going to be a sale — that additional step requires both a desire for a product or service and the wherewithal to acquire it. But when you're a salesman and you see a potential customer's acceptance, then you're in line to change the accepted interest into something more.

Selling is between people; it always has been, always will be. On a daily basis in retail, potential customers are turned off by service that is too in your face, too lax, too condescending or even downright hostile. This happens even when the customer is really intending to acquire a proffered product. Such behaviors are not the best way to survive in retail. In professional sales, there are similar messages that you must avoid: Don't embarrass the decision maker in front of his or her staff; don't fluff up the product; don't exaggerate corporate capabilities.

But you do have to overcome a major hurdle on many occasions in both situations: want vs. need. A customer's wants are often at a great variance to a customer's needs, which is something that must be gotten over if you want the sale not only to happen but also to "stick."

The political messages that are now being thrown at us — to sell to us — on a daily basis, particularly from what I would call *talk television*, are news programs that are on the edge of being merely political forums (or perhaps it's the reverse). They thrive on pre-arranged positioning and phony talk with word repetition by the contributors in order to drive home the message: "Social Security is broke;" "we've turned the corner;" "freedom is on the march." It is in the style of the advertiser hidden under the guise of an "expert" opinion. How did we let this news advertorial happen? How did we allow the system to be spun at the White House, where phony day passes are given to invented correspondents? How brazen does a system have to be for the majority of us to just look at it and tell ourselves we are being duped and regarded as stupid in the process?

The rise of talk television and its spin is because the networks have failed to do their jobs.

The older, retired network reporters would tell you, now that their jobs are not in jeopardy, that the rise of talk television and its spin is because the networks have failed to do their jobs. It is because the networks have dramatically reduced the number of feet on the ground, relying instead on feeds from the likes of AP, AFP or Reuters. Most local news programming is equally damned. They lead with some national/international agency stories — just to show that the stations are not parochial hacks — then move to some inconsequential local stories (preferably of the man-bites-dog or sob variety) and the inevitable freeway chase in the bigger cities. Then comes the plug for one of the station's shows, followed by sports (why do sports commentators always have such inane smiles?) and, of course, our local weatherman, usually a quasi-meteorologist.

We are driving intelligent people away from domestic broadcasting for their news. The intelligent ones are those who don't mentally link Saddam Hussein and 9/11; those who worry more about Medicare's gargantuan problems rather than Social Security's easily solvable ones; and those who have watched *Control Room* and realize that the ex-BBC employees at Al Jazeera are making a more honest attempt to bring facts from the battlefield than our networks.

Those who want the complete picture now get their news from the likes of the BBC, London's *Daily Telegraph*, the amazingly unbiased *Christian Science Monitor* and, progressively more, from blogs. Unless they wake up, the networks are going to be increasingly marginalized in what they used to do so well. **BE**

Paul McGoldrick is an industry consultant based on the West Coast.

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