NOVEMBER 2008

BroadcastEngineering

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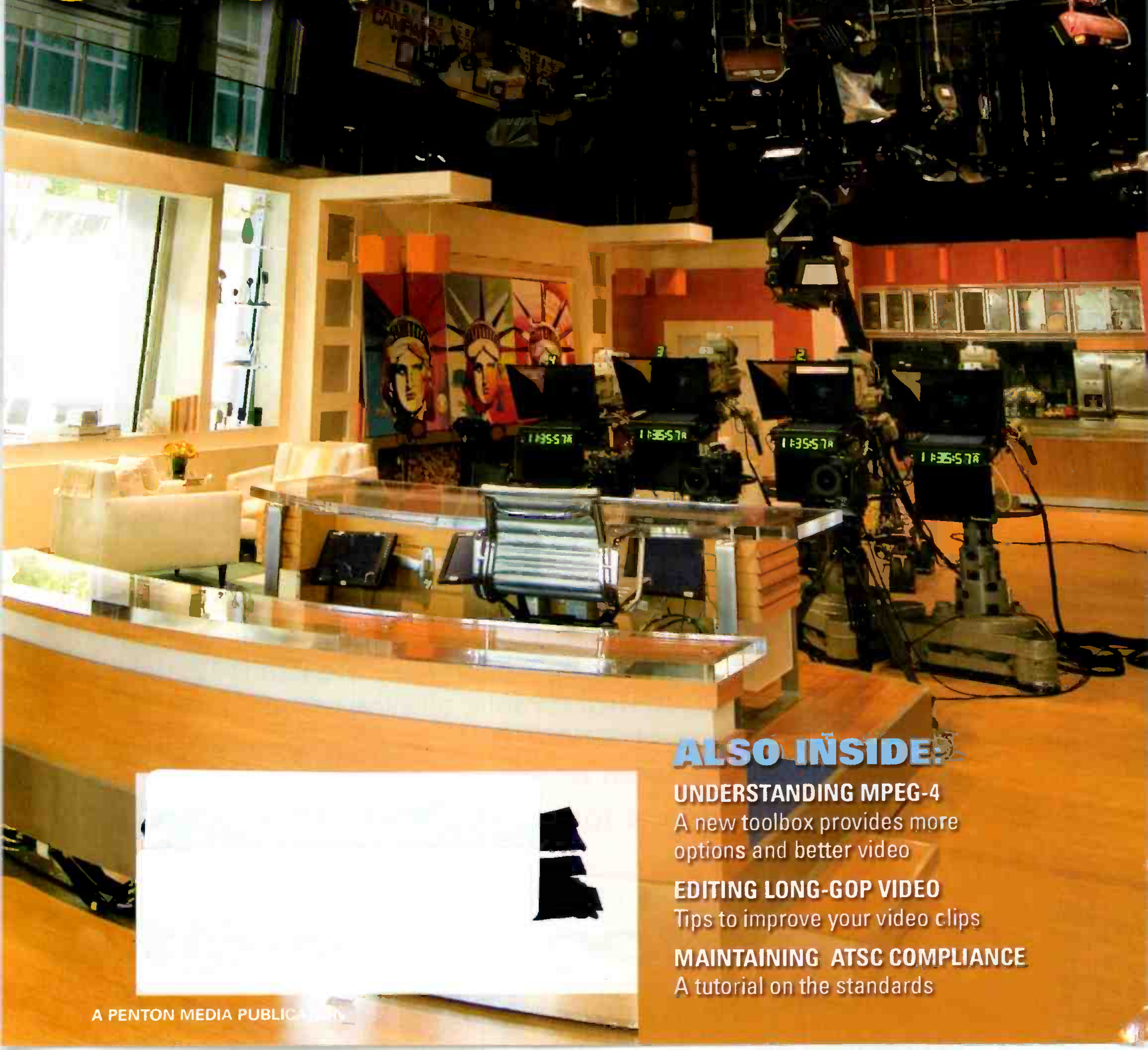
PLANNING TV PRODUCTION SPACES



ALSO INSIDE:

UNDERSTANDING MPEG-4
A new toolbox provides more options and better video

EDITING LONG-GOP VIDEO
Tips to improve your video clips

MAINTAINING ATSC COMPLIANCE
A tutorial on the standards

A PENTON MEDIA PUBLIC

WHEATSTONE D-9 Audio Control Surface at WPEC-TV, West Palm Beach, Florida

D-5.1 Master Control

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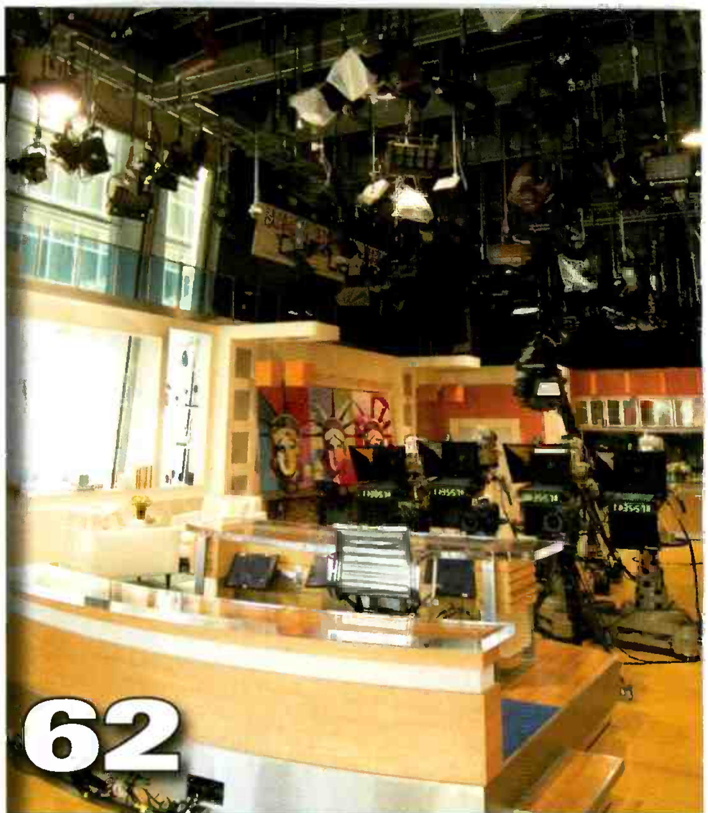


ON THE COVER:

CBS' "The Early Show" features a street-front studio created by production designer Jack Morton/PDG and lead designers Jim Fenhagen and Larry Hartman.
Photo courtesy TOMI Studio.

NOVEMBER FREEZEFRAME QUESTION

1) The difference between a quantized signal and its original is a low-level signal known as quantization error, or noise. The level and characteristics of the quantization noise for a sine wave are defined by the type of quantizer, the quantization resolution and one more factor. What is that factor (B), given the following formula: SNR = 6.02B + 1.76?
   a) Error rate in samples per second
   b) Sampling frequency
   c) Number of bits
   d) Baud per second

2) For signals other than a sine wave, other formulas apply. However, in general, each added bit of resolution cuts the noise level by how many dB?
   a) 0.5dB
   b) 3dB
   c) 1dB
   d) 6dB

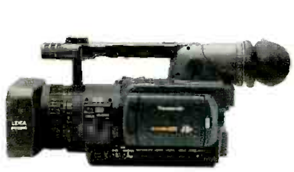
even **twins** have their own **personalities.**

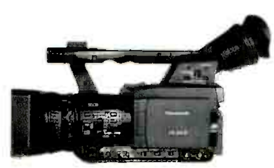
the beauty of P2 HD in two new handhelds

Like twins, Panasonic's new AG-HPX170 and AG-HVX200A full production quality P2 HD handheld camcorders are as alike as they are different. They both offer a 13X Leica Dicomar zoom lens; 1080i/p and 720p and 4:2:2 independent-frame recording; variable frame rates; a new, advanced 3-CCD progressive imager with spectacular quality; and the reliability and flexibility of a fast, file-based workflow.

Why might you prefer one over the other? The HVX200A features a DV tape drive in addition to two P2 card slots, allowing you to move easily from SD to HD and from tape to solid-state. If you have already transitioned to a solid-state file-based workflow, the two-slot HPX170 offers additional high-end features, including HD-SDI, metadata input, Dynamic Range Stretch and a 5-year limited warranty (upon product registration).

The HVX200A and HPX170. Distinctly different, yet uniquely alike. Learn more at **www.panasonic.com/p2hd**.





AG-HVX200A	AG-HPX170
• *11 variable frame rates*	• *20 variable frame rates*
• *4.2mm – 55mm*	• *3.9mm – 51mm*
• *Lightweight – 5.5 lbs*	• *Lightweight – 4.2 lbs*
• *3.5" flip-out LCD*	• *Waveform/Vectorscope*
• *21 HD and SD formats*	• *3 focus assist functions*

P2HD **when it counts**

Panasonic ideas for life

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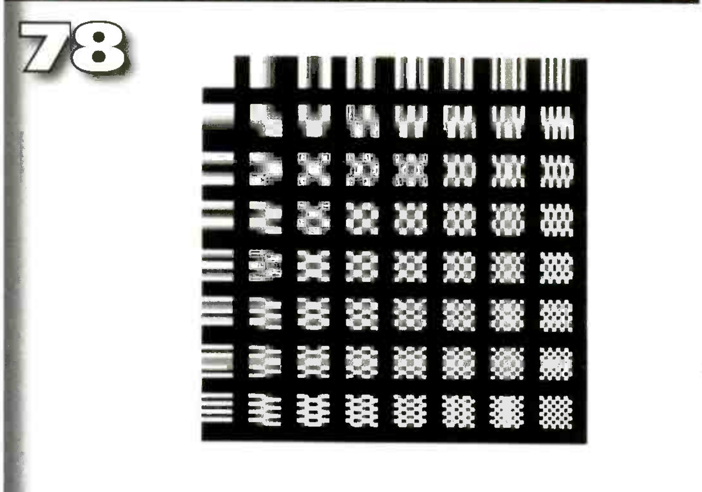
SYSTEMS INTEGRATION

NEW PRODUCTS & REVIEWS

DEPARTMENTS



NOVEMBER FREEZEFRAME ANSWER

Question 1: c

Question 2: d

A thorough discussion of sampling is available in "Digital Audio 101," by Aldo Cugnini, from the September 2007 issue of *Broadcast Engineering*. It is also available at *http://broadcastengineering.com/audio/digital_audio/index.html*.

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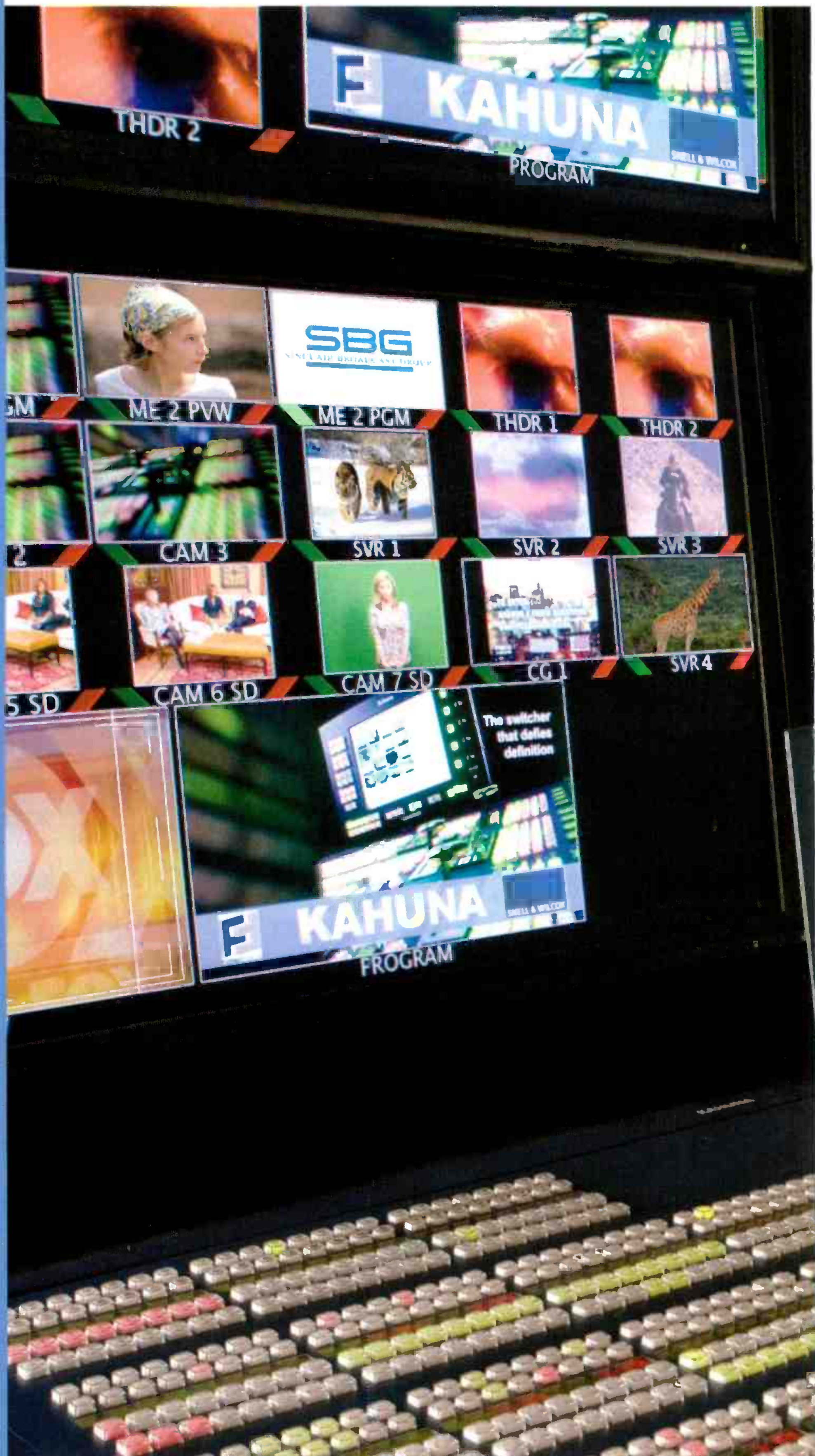

When you're responsible for the transition to HD news at one of the country's largest TV station groups, you need to ensure seamless integration of SD and HD material. That's why Sinclair's Mark Nadeau put Kahuna™ at the heart of his HD transition strategy.

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To find out why Sinclair chose Kahuna, visit snellwilcox.com/sinclair

KAHUNA

Answer the phone!

What will you be doing on the morning of Feb. 17, 2009?

I'm guessing a lot of *Broadcast Engineering* readers will be answering viewer telephone calls. Those callers will be asking, "Where's your signal? Are you off the air?"

After you explain that the station is still transmitting, but only in digital, what do you say to, "What do I have to do in order to get your signal?"

A community-wide analog shutoff test was conducted two months ago in Wilmington, NC. The results showed that despite massive promotion, viewers were hardly ready for DTV.

Elon University's associate dean of the School of Communications, Connie Book, initiated a research project where students documented the stations' switchover and then collected demographic and DTV-relevant information from viewers who called the stations for help during the test.

The results showed that viewers were highly incapable of resolving their DTV reception issues. Although many callers had converter boxes, the students working the phones still had to instruct callers on a variety of DTV reception issues, ranging from how to connect an antenna to the STB to the need for a better antenna.

The less-than-stellar initial DTV launch was predictable according to Barry Goodstadt, senior vice president for the market research firm Centris. Goodstadt has been sounding an alarm since last February when his company released its own research predicting that DTV coverage will not live up to expectations, primarily because of viewer antenna issues.

In a telephone interview conducted by *Broadcast Engineering* contributor Michael Grotticelli, Goodstadt said he found the initial reports of viewer antenna problems disturbing. "In the scheme of things, Wilmington is a fairly flat area," he said. "We have found on average that 54 percent of over-the-air households will have trouble and estimated that number would be half in Wilmington."

While acknowledging that the Wilmington results may not be predictive, Goodstadt said the anecdotal evidence isn't good news for TV stations. "The fact is that even visible [problems related to consumer antennas] suggest that other areas where there is variable terrain will have bigger problems, which will be much more apparent," he said. "Wilmington, in effect, is the tip of the iceberg."

Did he say iceberg?

Last month, Nielsen revealed that more than 9 million households in the United States are unprepared for the February 2009 DTV transition.

Additionally, 12.6 million other households have at least one TV set that will not work after analog transmitters go dark. Combined, the findings show that nearly one in five American households is either partially or completely unready for the transition. Does that trouble anyone?

Broadcasters can legitimately say we are ready, but is our audience?

In light of the reception issues raised in the nation's first large-scale test and the overall importance of the matter to both broadcasters and viewers, other cities have plans to conduct their own DTV tests. Although, one might wonder how many of those 60-second tests are scheduled more for political cover than technical discovery.

Even so, the many reception factors such as station channel changes, terrain effects and justifiable consumer ignorance make just about anything this industry does in preparation for the shutoff better than just standing by as the iceberg moves ever closer. BE

Brad Dick

EDITORIAL DIRECTOR

What plans do you have to help viewers with the DTV transition? Share your station's plans at *http://community.broadcastengineering.com/forums/80.aspx.*

Flying the not-so-friendly skies

In response to your October editorial, "IBC was great, minus the travel," you hit it right on the mark. I have been flying for approximately 40 years and see the progressive deterioration of simple creature comforts on commercial travel.

I raised three wonderful children and am often shocked to witness how modern parents simply do not teach respect and proper public behavior to their children. There were many times when strangers went out of their way to compliment my wife and me on the outstanding behavior of our children while in restaurants or other public venues.

That said, I doubt that any amount of public complaining will change things, nor will we ever see the day when there is an adults-only seating section on an airline. My preference, when I can justify the almost $6 per gallon of avgas price, is to use private aircraft, where there is always an adult-only seating section. While there are no trips to the galley or restroom, it sure beats the security lines, waiting periods and lack of legroom seating. Unfortunately, it is a heck of a long trip to Europe.

Oh well, thank goodness for the Bose noise-cancelling headphones!

Lanny Nass
CBS

Back to the future

Dear editor:

In Anthony Gargano's "Back to the future" article in your August issue, he states:

"The first cable television system is usually recognized as the system built in Astoria, OR, in 1949 by appliance dealer Ed Parsons. Ed wanted to sell television sets but found that a bit challenging because Astoria didn't receive any signals. That's hard to imagine in this era of hundreds upon hundreds of channels to select from over cable, satellite and telco fiber. Back then, off-air was the only option, and there were less than 100 television stations in the United States.

Ed, armed with an FM receiver to tune TV audio, explored the surrounding countryside to find a place where he could receive a signal. When he did, he strung some cable from that spot to his newly sold receivers, thereby giving birth to CATV."

I believe this is incorrect. Service Electric Cablevision was started in 1948 by John Walson in Mahanoy City, PA. He has been nationally recognized as being the founder of the first cable operating system. However, there are a few other individuals who argue the fact that they started cable years later. Mr. Walson, the founder, was the first.

Sam Lesante, Jr.
VP/CPO
Sam-Son Productions
Hazleton, PA

Anthony Gargano responds:

Many thanks for your comment, Sam. Actually, truth be known, I started out my career working on what broadcasters would have then referred to as the "dark side" — the cable television industry. My first job was working for Milt Shapp in 1964 at Jerrold Electronics, one of the pioneering equipment suppliers to the cable industry. Jerrold was eventually acquired by General Instrument, which itself was subsequently acquired by Motorola.

Through working at Jerrold, I had the pleasure of knowing Johnny Walson. He was a character and a really great guy. And yes, he always laid claim to building the first cable system. To this day, the claims of who really built that first system remain unresolved, and attribution of that honor varies by institution or publication.

For my article, I cited Ed Parsons as being the first because the National Cable Television Center and Museum in Denver, now called simply The Cable Center, attributes that honor to him. But knowing the differing opinions as to whom the honor belongs, I was careful to use the term "usually recognized."

By the way, Milt liked to claim that he built the first real cable television system!

Great stuff, Sam. Thanks for reading.

Test Your Knowledge!

See the Freezeframe question of the month on page 4.

Beyond HD

Will 1080p improve the quality of HDTV?

BY CRAIG BIRKMAIER

Does anyone out there still have a dot matrix printer? It seems they have gone the way of the horse-and-buggy and round tube TVs, a term that the consumer electronics industry is using to put the last nail in the shipping crates for CRT-based displays.

In 1984, I bought my first computer and first printer, a dot matrix machine that could print at 72 dots per inch (DPI), which also happened to be the resolution of the Mac Classic display. The term what you see is what you get (WYSIWYG) was coined to describe the benefits of a graphical user interface and printer that could reproduce what you saw on the computer screen. Unfortunately, the results had more in common with the mechanical TV demonstrated by John Logie Baird in 1926 than a modern ink jet or laser printer.

Much the same can be said about the evolution of TV from the early experimental days through the worldwide deployment of 525-line (NTSC) and 625-line (PAL/SECAM) systems to today's SDTV and HDTV systems with 480, 576, 720 and 1080 lines. We are only a decade into the era of HDTV, yet some folks are already talking about moving beyond HDTV. In fact, the consumer electronics industry is now promoting 1080p displays, despite the fact that nobody is broadcasting 1080 at 50p or 60p, or is planning to in the near future.

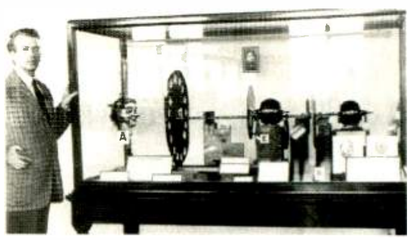
Commercial TV became possible thanks to the round tube TV, like this one from Zenith.

The trouble with dot matrix printers, and legacy TV systems, is that they did not offer enough resolution to deliver high-quality, alias-free images. Despite this shortcoming, however, TV has prospered, based primarily upon the content that is delivered, rather than the quality of the pictures. While digital television can deliver outstanding quality pictures, the unfortunate reality is that what we watch today is often compromised by the decision of program distributors to focus on quantity rather than quality.

So what gives with the seeming disconnect between the quality of the images that go into the transmitter and the push for displays that offer far more resolution than a broadcast can deliver? And why are people talking about even higher resolutions for TV image acquisition?

Decoupling and oversampling

Baird's television system used a camera with a rotating disk to sample the image. The display had a rotating disk that recreated those samples. The major advancement that made commercial TVs a practical reality was the development of the round tube TV, aka, a scanning CRT display.

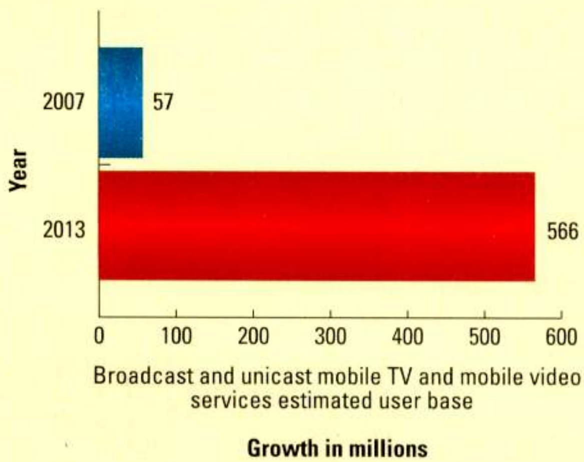


John Logie Baird first demonstrated his mechanical TV system in 1926.

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

Broadcast and unicast mobile TV video services to grow

Users will increase from 57 million in 2007 to 566 million in 2013.



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The DP600-C version adds faster-than-real-time encoding, decoding, and transcoding of Dolby Digital, Dolby Digital Plus, Dolby E, and MPEG-1 LII formats.

New for both DP600 configurations is an optional software upgrade that adds intelligent file-based upmixing functionality based on a newly developed Dolby algorithm. It automatically creates 5.1-channel programs from stereo or Lt/Rt sources, and easily integrates into a work profile along with loudness correction, encoding, decoding, or transcoding.

The Dolby DP600 Program Optimizer is the complete audio processing answer for file-based work flows that saves time and money. For more information, visit **www.dolby.com/dp600**.

DP600 and DP600-C Applications

- Broadcast media file QC and loudness correction
- Broadcast media file transcoding
- File-based program upmixing
- VOD file analysis and loudness correction
- Loudness correction for digital program insertion (DPI)

The camera electronically scanned the image on a pickup tube from top to bottom, and the display scanned this image onto the surface of the round tube display. We could delve deeper into interlaced vs. progressive scanning, but for the purpose of this discussion, the important takeaway is that everything was tightly coupled. The camera and the receiver/display all operated synchronously using the same scanning parameters.

This image was taken from John Logie Baird's mechanical TV system.

With digital television, all that has changed. Image acquisition (the camera), image processing (production, master control and transmission) and reception/display are completely decoupled. Today, a TV program may be displayed on a 65in HDTV display, a notebook computer, an iPod or a cell phone. Low-quality images can be viewed on high-quality displays, and high-quality images can easily be encoded for delivery at multiple resolutions.

In most cases, the limiting factor in delivered image quality is not the camera or the TV. It is the bandwidth of the channel that is being used to deliver the compressed bits to the receiver, which in turn must decode these bits and present them on a display — any display, no matter the resolution.

A modern digital TV receiver must deal with video formats at multiple resolutions, converting them to the resolution of the local display for presentation to the viewer. And that DTV display may be connected to additional sources of bits, which have different characteristics from a video signal, like video game consoles and multimedia PCs. Some TVs are even shipping with integrated Web browsers that bring the world of Internet content to the big screen in the family room.

There is one golden rule when it comes to the creation and delivery of high-quality imagery, whether it is video, digital photography or computer-generated images. It is desirable to start with higher quality than you plan to deliver. The term for this is oversampling. In laymen's terms, it is the difference between a dot matrix printer that creates characters and images at 72DPI versus a laser printer that produces characters and images at 300DPI. More samples allow the digital imaging system to reproduce higher frequencies without aliasing artifacts.

The limiting factor in delivered image quality is not the camera or the TV. It is the bandwidth of the channel that is being used.

Oversampling is highly beneficial in cameras as it helps to eliminate sampling errors and minimize the effect of noise on the sampling process. When we oversample and then resample to a lower resolution, we improve the overall accuracy of the image. This pays significant dividends when the imagery is digitally compressed for emission. Reducing the number of samples that must be encoded, along with improving the accuracy of the samples, makes it possible to deliver higher quality images in bandwidth-constrained channels.

You do not want to push the sampling system and the compression system to the limits. But this is what many broadcasters have chosen to do with HDTV. By selecting the interlaced 1080i format, they are compromising the acquisition system in two ways. First, interlace is a spatial/temporal undersampling system. This adds stress to the MPEG compression system, which is optimized for frame-based images (progressive scan). Second, most current camera designs cannot oversample the 1920 x 1080 format. Many of the less expensive cameras use sensors that only have 960 to 1440 samples per line. This results in less accurate samples that require more bits to compress.

Progressive image acquisition and processing improves the quality of the samples, which reduces stress on the MPEG encoder. And the lower sample rate leaves more room in the 19.3Mb/s ATSC payload to handle peak bit-rate requirements. Oversampling to create 720p further improves the image quality.

Display oversampling

In the decoupled world of DTV, oversampling plays a significant role in display quality as well. One of the major limitations of NTSC and PAL (in addition to the use of interlace) is that the scanning lines become visible as the display size increases, and the artifacts associated with interlace accentuate the perception of the scanning lines in the raster. NTSC was designed to produce a sharp picture on a 19in display viewed at seven picture heights. As larger CRT displays became more common, the perception of both image artifacts and the raster was more apparent. The move to HDTV was driven primarily by the need for more samples to create sharp images on larger displays.

Today we find many display resolutions in the marketplace, some of which are different than any of the

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The Drawn Together images are courtesy of Comedy Partners.

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ATSC formats. The good news is that virtually all flat-panel and projection displays being sold today offer progressive scanning. But the consumer electronics industry is pushing consumers to purchase displays with 1080p resolution, often in display sizes where the viewer will not be able to resolve this level of detail.

As a rule of thumb, 1280 x 720 resolution is adequate for displays with diagonals up to 50in; 1920 x 1080 is only needed for displays larger than 50in at typical entertainment viewing distances. But that excess resolution is not necessarily a bad thing; it helps to suppress the perception of the display raster, and it may be useful for other applications, such as viewing a Web page on the TV display.

In this, modern TVs are much like computer displays. They can present properly sampled video images with high quality, and they can present computer-generated samples that would cause aliasing in video images. Thus a smaller (e.g., 32in) 1080p display may have more resolution than the viewer can see when sitting at five to seven picture heights, but that resolution may be useful when viewing a Web page — albeit by moving closer to the screen to see the additional details.

We are also seeing HDTV displays that are oversampling in the temporal domain as well. In Europe, 100Hz displays have been common for several decades to help minimize the perception of 50Hz flicker. Many manufacturers are now selling 120Hz HDTV displays, with image processing engines that can improve the quality of 24p source images.

In the United States, we have lived with improper presentation of 24p since the inception of TV service at 60Hz, which became 59.94Hz when color was added. This required a frame repetition technique known as 3:2 pulldown. In a theater, the projector typically operates at 48Hz or 72Hz, displaying each frame two or three times. To convert the 24p source to 60 video fields, one frame is repeated for three field periods, the next for two field periods. This disrupts the motion adding to the problems that exist with the low 24p acquisition rate.

New 120Hz HDTV displays would allow each film frame to be displayed five times, eliminating the uneven motion rendition of 3:2 pulldown. But these displays go a step further and create in-between frames using sophisticated motion-compensated prediction techniques. The result is smoother motion that one would see in a theater.

Beyond HDTV?

There is a great deal of interest in new imaging systems that offer resolutions well beyond today's HDTV. For applications where the imagery is presented on very large screens, this is both desirable and practical. For a consumer television system, however, there are many things we need more than increased resolution.

First and foremost, we need to deliver high-quality samples, even if this means reducing the resolution slightly to make the content fit the channel's bit budget. The vast majority of digital content offered today is significantly over-compressed. Needless to say, trying to squeeze 1080 at 60p into an existing ATSC channel is only going to worsen the delivered image quality.

Next, we need to get rid of interlace, both as an image acquisition format and as an emission format. And finally, we need to take full advantage of the benefits of oversampling, both during image acquisition and at the display. If we do these things, we will move beyond the limitations of what is rapidly becoming a legacy HDTV system. BE

Craig Birkmaier is a technology consultant at Pcube Labs.

? Send questions and comments to:
craig.birkmaier@penton.com

News from the DTV front

Stations have an opportunity to transition to digital early.

BY HARRY C. MARTIN

While the final transition date has long been set at Feb. 17, 2009, some stations may want to terminate their analog operations before then. For stations in that category that are willing to hold off until Nov.17, the FCC has worked out an analog turn-off plan with minimal regulatory hurdles.

Early transition opportunity

Most stations will be able to drop their analog channels on Nov. 17 without prior commission approval if they broadcast notices on their analog facilities for at least 30 days, beginning on or before Oct. 18. These notices must alert the audience about the anticipated termination date and inform them about how they can continue to receive the station. Stations choosing this option also will have to notify the commission of their plans at least 30 days in advance through a filing using the FCC's CDBS data system. Stations with flash-cut construction permits cannot avail themselves of this procedure and must seek STAs if they want to cease analog operations.

Wilmington has 180,000 households of which 14,000 rely on over-the-air signal delivery. On the first day of the Wilmington test, about 800, or 6 percent, of the 14,000 residents called the FCC helpline.

Licensees wishing to cease analog operations prior to Feb. 17, 2009, are required to notify the public in over-the-air messages containing the following information:

- the station's call sign and community of license;
- the fact that the station is planning to reduce or terminate its analog operations before the transition date;
- the date of the planned reduction or termination;
- what viewers can do to continue to receive the station, i.e., how and when the station's digital signal can be received;
- information about the availability of digital-to-analog converter boxes in their service area; and
- the street address, e-mail address (if available) and phone number of the station where viewers may register comments or request information.

Stations turning off their analog on or after Nov. 17 must air four such announcements daily (at least one in prime time) for the 30 days prior to turn-off.

Early transition in Wilmington, NC

The FCC's evaluation of the early DTV transition in the Wilmington, NC, market was positive. According to the commission, "the vast majority of the 400,000 television viewers impacted by the change ... seemed to be prepared for it." This should not be surprising. The FCC and the local stations blanketed the community with transition information for weeks.

Wilmington has an estimated 180,000 households of which 14,000 rely on over-the-air (i.e., noncable, nonsatellite) signal delivery. On the first day of the Wilmington test, about 800, or 6 percent, of the 14,000 residents called the FCC helpline. And this occurred in a market that had been overwhelmingly blanketed with information. It remains to be seen how smoothly the nationwide transition will go in other markets, where it will not be possible to mount the same level of concentrated public education as was done in Wilmington. BE

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

? Send questions and comments to: harry.martin@penton.com

Dateline

- Dec. 1 is the deadline for TV stations in the following states and territories to file their biennial ownership reports: Alabama, Connecticut, Georgia, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont.
- Dec. 1 is the deadline for TV stations and Class A stations in the following states and territories to place their 2008 EEO public file reports in their public files and post them on their Web sites: Alabama, Colorado, Connecticut, Georgia, Maine, Massachusetts, Minnesota, Montana, New Hampshire, North Dakota, Rhode Island, South Dakota and Vermont. LPTV stations originating programming in these locations, which are not required to have public files, must post these reports on their Web sites and keep them in their station records.

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When you get your hands on a UTAH-400, you've got all the routing power you'll ever need.

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Yet the real power is in the reliability. With multiple redundancy options, round-the-clock support, and the best warranty in the business, you can't get a more solid system.

On the other hand, it's also flexible, expandable, and affordable. Contact us today and we'll spec a UTAH-400 that's just right for you.

Note: while the UTAH-400 offers more power to broadcasters, as an extra bonus, it actually consumes 25% less energy than similar systems, providing cooler, cleaner, and less-expensive operation.

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MPEG's upgrade

This tutorial will help you understand MPEG-4's distinctive features and functions.

BY ALDO CUGNINI

Although MPEG-2 continues to enjoy widespread deployment over broadcast and DVD media, MPEG-4 is rapidly catching up, thanks to advances in algorithms, processing power and storage. And while the original video codec of MPEG-4 — called Part 2 or Visual — delivered the ability to perform object-based coding, the feature was quickly superseded by the efficiency improvement provided by Advanced Video Coding (AVC), i.e., MPEG-4 Part 10 (ITU H.264).

Toolkit

MPEG-4 provides a more enhanced toolkit than its predecessors, yielding up to HDTV resolution with as much as a 50 percent reduction in bandwidth. Some of the key features of MPEG-4 are listed in Table 1.

MPEG-4 profiles	Features
Simple Visual Profile	Similar to MPEG-2 coding
Advanced Simple Visual Profile	B-frames, global motion compensation and interlace
Core Visual Profile	Binary shapes (video objects) and B-frames
AVC Baseline	Low delay and lower processor load
AVC Main	Interlaced video, B-frames and CABAC encoding
AVC Extended	Error resilience tools
AVC High	Fidelity range extensions and high-quality, high-resolution formats for HDTV and digital cinema

Table 1. MPEG-4 adds new features to the compression toolkit.

MPEG-4 Visual first introduced the concept of video objects and video object planes. In contrast to coding an entire picture, a background image can be coded over which a foreground video object plane is separately coded. One typical application of this is in synthetic or computer-generated images (e.g., animation), where objects routinely move in front of a fixed or slowly moving background image.

In fact, a sophisticated encoder can make use of this technique when coding live-action video as well, with scene-detection algorithms capable of detecting moving foreground objects such as people and faces. However, while this type of coding has relevant applications for video conferencing systems, its widespread use has not grown, perhaps in part because of the amount of processing horsepower needed.

AVC features

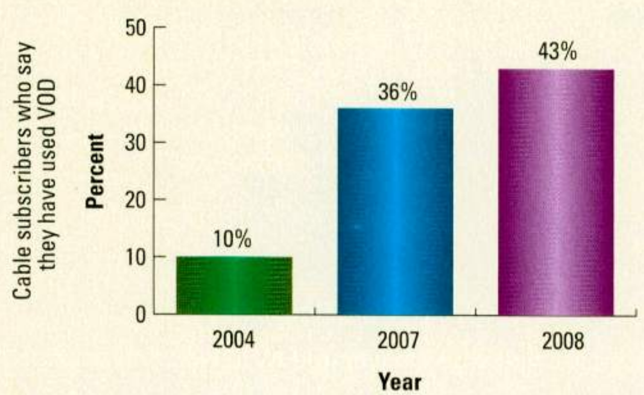
AVC introduces various new picture coding tools for interlaced pictures, such as picture-adaptive frame/field coding and macroblock-adaptive frame/field coding. These allow several choices: coding each field separately; combining two fields together and coding them as a frame; or combining two fields into a frame while splitting pairs of vertically adjacent macroblocks into either field

FRAME GRAB

A look at tomorrow's technology

Number of cable subscribers who have used VOD increasing

In 2008, 43 percent of cable subscribers utilized video on demand.



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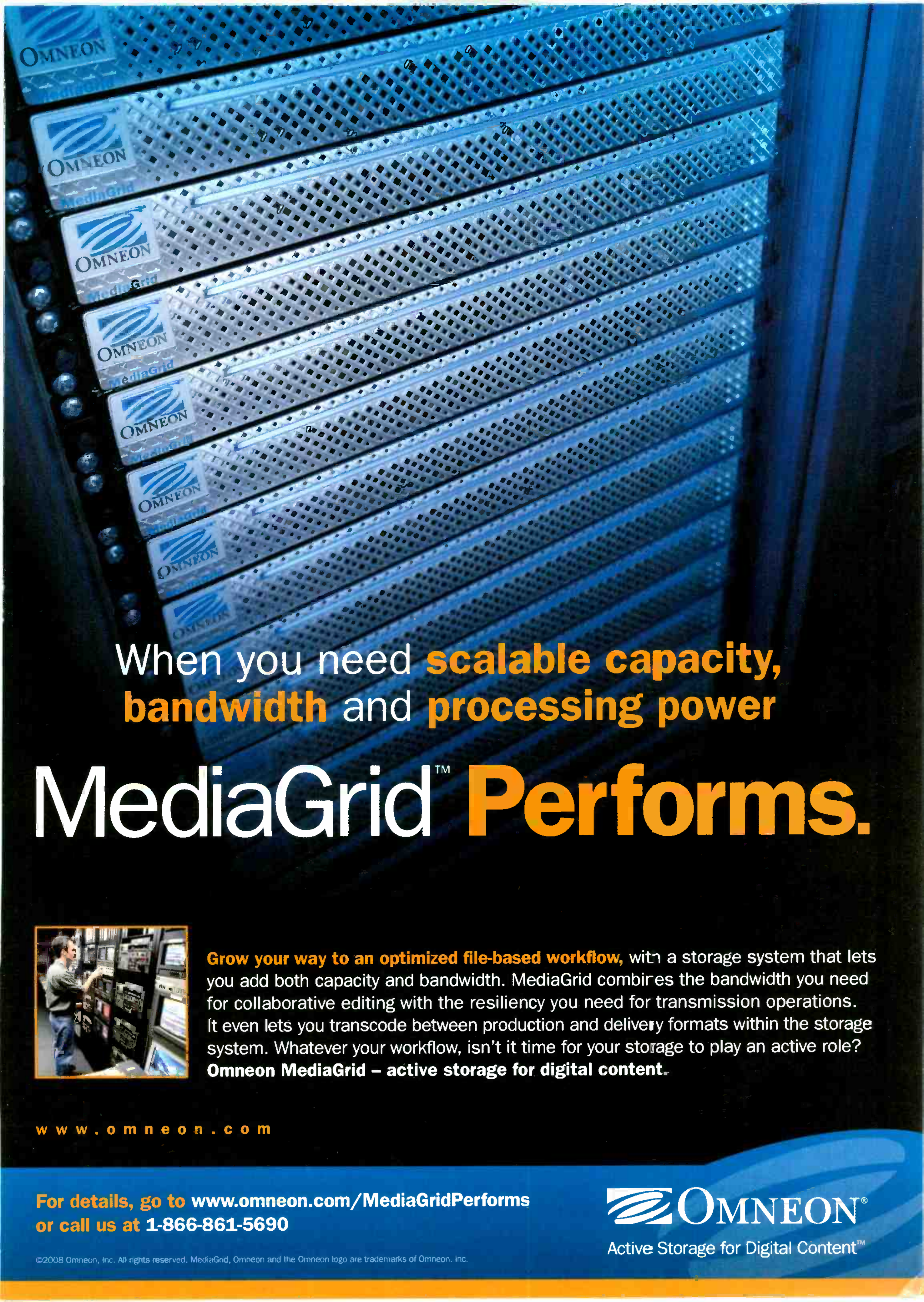

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macroblocks or frame macroblocks. AVC thus enables different macroblocks to be coded as either field or frame within the same picture. In addition, the prediction method for each coded macroblock can be one of several different types, such as intra, inter, forward, backward and bidirectional. Macroblocks can also be partitioned into smaller horizontal and/or vertical submacroblocks.

While MPEG-2 uses fixed anchor frames to predict the intercoded frames, AVC introduces the concept of multiple reference frames for interprediction. A reference frame index identifies one of several lists of reference frames so that predictions can efficiently account for back-and-forth scene cuts and object occlusions. (See Figure 1 on page 28.)

AVC also adds error resilience tools that can help to reduce the visibility of artifacts when errors occur. These include additional picture and slice types, such as switching intraframes (SI-frames) and switching predictive frames (SP-frames), and flexible macroblock ordering. SI- and SP-frames (or slices) are coded to allow efficient switching between different pictures, allowing correct pictures to be built up in a decoder (even when there is missing information) by using a choice of different reference frames (or slices). SI- and SP-frames can also be used to facilitate bit stream switching.

AVC also expands on the way that the various symbols, such as motion vectors and residual data (transform coefficients) are coded, by adding techniques for variable length coding (VLC). VLC is a reversible, lossless procedure for entropy coding that assigns shorter bit strings to frequent symbols and longer bit strings to less-frequent symbols. Three types of coding are available in AVC: Exponential-Golomb (or Exp-Golomb) coding, context-adaptive variable-length coding (CAVLC) and context-based adaptive binary arithmetic coding (CABAC).

Exp-Golomb is the baseline entropy coding method of AVC, which relies on a single code word set that is used for all syntax elements except for the residual data. The fixed tables of Exp-Golomb, however, as well as those used in MPEG-2 and other codecs, do not allow an adaptation to the actual image transform statistics, which may vary over space and time, as well as for different source material and coding conditions. With CAVLC, intersymbol redundancies are exploited by switching VLC tables for various syntax elements, depending on already-transmitted coding symbols. In this way, CAVLC is more efficient than the MPEG-2 VLC.

To encode pixel data, AVC uses a simpler transform than the discrete

cosine transform (DCT) used in MPEG-2. The new transform (and quantization) can be carried out using integer arithmetic and a single multiply per coefficient, enabling a reduction in complexity. Transform coefficients are then coded using run-length and level. If there are runs of zeroes in the transform (as is commonplace), the level of the preceding coefficient is coded, along with the number of zeroes afterward. AVC goes past MPEG-2 in additionally coding the number of trailing ones (T1s). From a statistical standpoint, most blocks of video contain relatively little detail information. Therefore, the level (magnitude) of non-zero coefficients tends to be higher at the start of the transform array (near the DC coefficient) and lower toward the higher frequencies. CAVLC takes advantage of this by adapting the choice of the VLC lookup table depending on the number of non-zero coefficients and trailing ones in neighboring blocks.

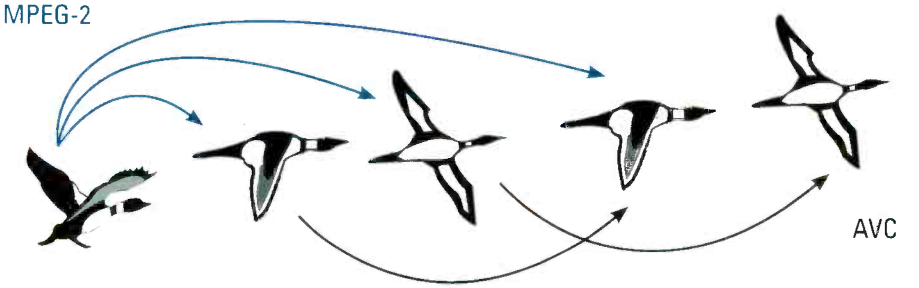

Figure 1. MPEG-2 is limited to showing each frame in succession. AVC, however, can use multiple reference frames.

The CAVLC method, however, cannot adapt to the actual symbol statistics (i.e., the statistical occurrence of the symbols themselves). CABAC adapts to the statistics of the actual bits in the data stream by using a context model that describes the probability of occurrence of one or more bits of a data symbol. This model may be chosen from a set of available models, depending on the statistics of recently coded data symbols. An arithmetic coder (a form of VLC) then encodes the data according to the selected probability model. Finally, the selected context model is updated, based on the actual coded data. The system essentially learns the best way to code the symbols. (See Figure 2.)

CABAC compresses data more

efficiently than CAVLC, but requires considerably more processing power to encode and decode. Consequently, it's not commonly used in low-cost architectures such as handheld devices. Nonetheless, experimental results have shown the superior performance of CABAC compared to CAVLC. To evaluate the quality of digital video processing, the peak signal-to-noise ratio (PSNR, a measure of the encoding error) of processed video signals can be calculated. For typical test sequences in broadcast applications, bit-rate savings can average 9 percent to 14 percent, at a range of acceptable video quality of about 30dB to 38dB PSNR.

An amendment to the MPEG-4 standard added the Fidelity Range Extensions (FRExt), forming the AVC High Profile. This includes high-performance characteristics such as 10-bit and 12-bit per sample quantization; 4:2:2, 4:4:4 and RGB color sampling; very high bit rates; and lossless coding of portions of video. Scalable video coding was also recently added to AVC, enabling the encoding of bit streams that include sub-bit streams at smaller temporal or spatial resolutions.

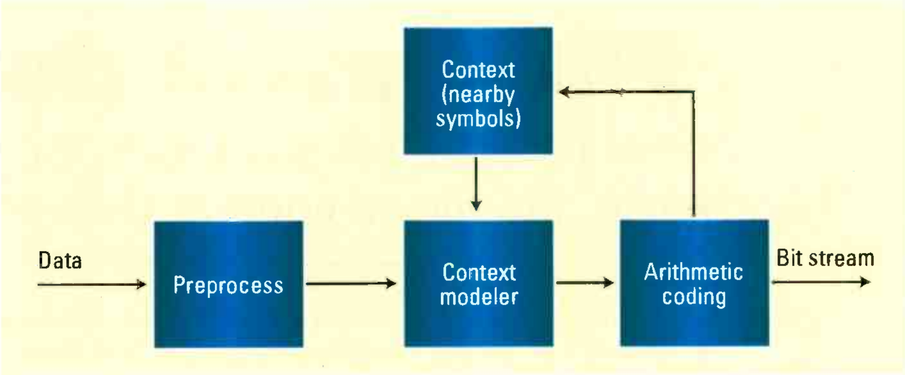

Figure 2. CABAC can adapt to the statistics of the actual picture data, resulting in very efficient coding.

AVC support is required for all Blu-ray disc players, so very high levels of video performance are now available to viewers, but of course at a cost. Notwithstanding the improvement from AVC, with the digital transition about to leapfrog in just a few months, and HDTV sales still growing, don't expect MPEG-2 to fade away anytime soon. **BE**

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File-based delivery

Thanks to technical advances and falling prices for bandwidth, file-based content delivery is more common.

BY BRAD GILMER

Five years ago, file-based content delivery was making inroads with broadcasters, but it was still a somewhat unusual way to deliver video. Now, file-based content delivery is the norm. Thanks to the deployment of key enabling technologies, less expensive networks and a rise in file-based content delivery to the consumer, file-based delivery is coming of age.

For decades, content was delivered to the broadcaster by one of two methods. Network programming was delivered on a network satellite, and syndicated programming and commercials were delivered by overnight courier. The network programming feed made sense because there was a single source distributing the same content to many stations. The overnight courier was an efficient way to do point-to-point delivery, where many different commercials were being sent from many originating points to many different broadcasters. While satellite transponder and shipping costs were not insignificant, they were, and in many cases they still are, the most cost-effective way to distribute content.

Almost as soon as the Internet came into being, broadcasters and content distributors began looking into ways to deliver content over this new medium. But financial and technical hurdles stood in the way. When it was developed, the Internet excelled at moving text from one place to another. Because even a small video clip is many times larger than the average text file, the cost of bandwidth was one of the major stumbling blocks to moving video over IP. Second, there was the last mile problem. You might be able to get high-speed connectivity between two cities, but it may be impossible to get a high-speed link over the last mile from a telephone company central office to the broadcast facility.

Today, bandwidth costs are falling, and while it may still be a determining factor in whether a particular project is able to move forward, in many cases, affordable connectivity for video distribution is available. Let us look at some key enabling technologies that have made file-based content delivery practical.

Digital video

It almost goes without saying that digital video technology is the keystone of file-based content delivery. From where we sit today, digital video is a given. But it was not clear at the time that the industry would be successful in creating a single ubiquitous digital video standard. Without its development, file-based content delivery would be impossible.

Video and audio compression

Without the development and deployment of interoperable, efficient video and audio compression, file-based content delivery would be just a dream. Compression ratios of 10:1, then 100:1 and now beyond have allowed broadcasters to lower their transmission costs with an acceptable impact on quality. The industry has been extremely well served by the development of compression and would not be where it is today without it.

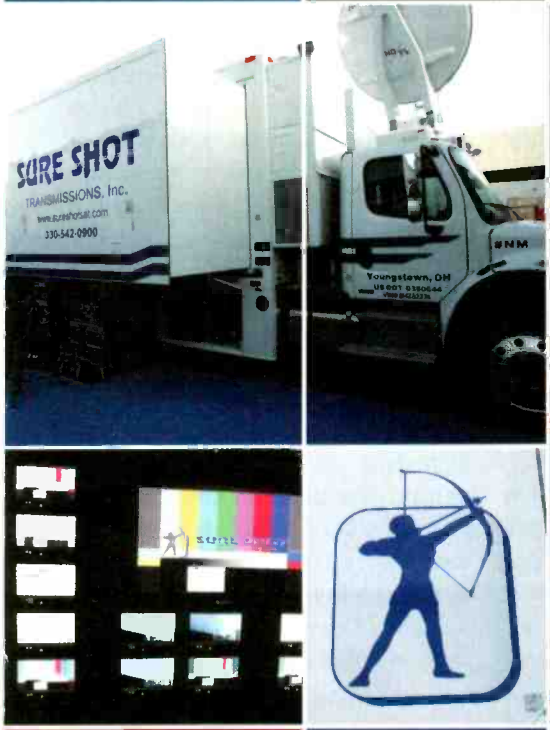
Extensible Markup Language

A comparatively new invention is Extensible Markup Language (XML). XML has allowed broadcasters and content distributors to include metadata about the files they are sending. The industry has recognized what a critical role metadata plays in the content distribution chain. The adoption of XML allows us to use many of the software tools developed in the computer industry for the construction and manipulation of metadata.

Fiber connectivity both between and inside broadcast facilities is now commonplace.

Material eXchange Format

The Material eXchange Format (MXF) is a wrapper that allows a content delivery service to wrap together video, audio, closed captioning and metadata in a single container. The container can be streamed from the content delivery service to the broadcaster and played directly, or it can be saved as a file. The power of MXF is in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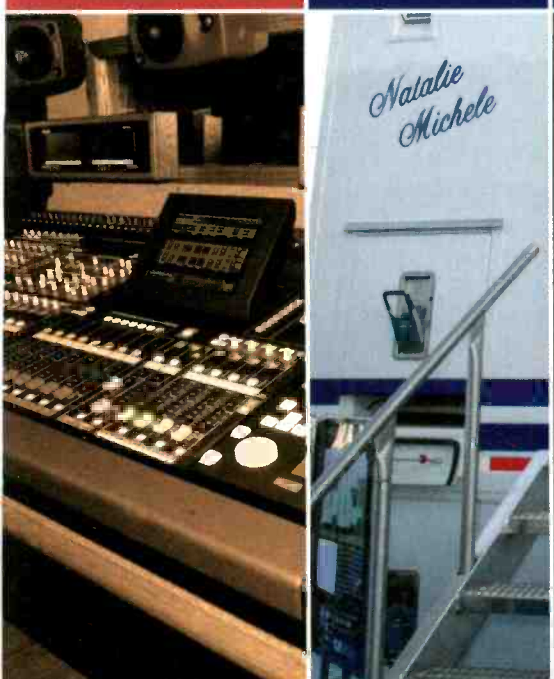
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its object model — the way metadata is arranged in the wrapper. A receiving application can decode the metadata in the MXF header and quickly determine if the content meets delivery specifications without detailed analysis of the contents of the file. Furthermore, the items in the file and the way they are referenced in the metadata have been standardized to increase interoperability.

Many fiber-optic cables have been installed over the last 15 years, making file-based content delivery a reality.

Error correction

Error correction has been around for many years. In fact, error correction has been available for files sent across the Internet since the Internet's inception. However, the industry is now discovering standardized ways of implementing error correction that allow interoperability among different implementations.

Peer-to-peer networking

Peer-to-peer (P2P) networking has been used on the consumer side of the Internet for quite some time. P2P gets around a number of issues with broadcasting over the Internet. It can be difficult to send the same file to hundreds or thousands of sources simultaneously, because traditionally, the sender must establish a one-to-one conversation with each receiver. Clearly, a traditional broadcaster would be overwhelmed if it had to electronically talk to each receiver. P2P allows portions of a file to be sourced from any number of senders, so the load of sending the file can be distributed beyond a single source. Several professional implementations of P2P have been created, and the implementation of this technology on the broadcast side is increasing.

One-way IP transmission

Because of the unavailability and high cost of connectivity, satellite transmission can still be the best way to reach some facilities. For file-based distribution, engineers came up with clever ways to modify existing IP technologies. IP was designed assuming that there would be a two-way conversation between the sender and the receiver. The predominant method of error recovery in IP requires that the receiver notify the sender that a packet has been lost so that the sender can retransmit the lost information. Without a return path, this and many other protocols designed to work over IP will fail. A few smart people have figured out how to make file-based delivery work using IP either without a return path or with a low-speed return path. Without these modifications, file-based delivery of content using IP would be impossible.

Large-scale fiber deployments

Over the last 15 years, the telecom industry has laid tens of thousands, perhaps hundreds of thousands, of miles of fiber-optic cables. No one knows exactly how much; the carriers keep this a closely guarded secret. At this point, fiber passes by most homes and businesses in metropolitan areas, and fiber is installed in all major league and most college sports venues. Some, but not all, last-mile problems have been solved by a massive investment in fiber by the telecom industry.

File-based delivery

File-based content delivery is increasing. Of course, when you consider the effective bandwidth of an overnight courier truck loaded with tapes, it is difficult to beat. Even so, demand for file-based delivery is growing.

There are several factors driving this. First, file-based delivery allows just-in-time delivery of content. For example, if an advertiser wants to change a commercial, it can do so closer to air using file-based delivery technology. Second, there are costs associated with filling the overnight courier truck with tape that go beyond the shipping costs. The costs associated with a national tape duplication facility are significant. Finally, depending on the technology used, file-based content delivery ensures that the copy created at a broadcaster's facility is either a bit-perfect copy of the original, or it does not arrive at all. This eliminates tapes that are rejected for duplication-related technical errors.

File-based content delivery is not a panacea. Traditional delivery mechanisms will probably coexist with file-based delivery for quite some time. But the technical advances described in this article coupled with falling prices for bandwidth mean that file-based content delivery is here to stay. BE

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

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Editing long-GOP video

H.264, with fidelity range extensions, provides an alternative to editing long-GOP MPEG-2 images.

BY STEVE MULLEN

When HDV was introduced, editors quickly discovered that when they exported a production back to HDV tape, the process often took hours. Many saw long export times as a reason to avoid long-GOP formats. At the same time, some marketing campaigns promoted the idea that long-GOP MPEG-2 was difficult to decode, making editing cumbersome. Also, so-called experts advised editors new to HD that MPEG-2 should be decoded in the VTR, sent via HD-SDI and stored as uncompressed video. Or, if that weren't possible, during capture, it should be transcoded to a better 4:2:2 codec.

Folks were also warned that if they edited long-GOP natively, the use of FX would result in poor quality because renders would be re-encoded to MPEG-2. And, worse, repeated re-encodings would further destroy quality.

The result of these warnings was a fear of native long-GOP editing. Thankfully, as NLEs were enhanced to support various types of MPEG-2 and more editors came to understand what really went on inside their NLE, this fear has lessened. (See "MPEG-2 editing myths.")

There remains, however, the issue of long export times — even with a cuts-only MPEG-2 timeline. The reason for the delay is that when a clip is trimmed during editing, the beginning and/or end of each clip likely has its GOP structure broken.

To obtain a perfect GOP series during MPEG-2 output, starting at the first frame in a timeline, every GOP is decoded to a sequence of YCrCb frames. Then, each series of six, 12 or 15 YCrCb frames are encoded into GOPs.

Smart GOP splicing

When you watch ATSC HD MPEG-2, transport stream sources are real-time spliced with frame accuracy. MPEG-2 data streams are spliced by shortening the GOP of the last clip (called the outgoing GOP), shortening the GOP of the next clip (called the incoming GOP) or shortening both GOPs.

Because MPEG-2 allows shorter than six-, 12- or 15-frame GOPs, it would seem the task is a simple one. Figure 1 shows an example where four

IBBPBB IBBPBB IBBPBB

becomes

IB IBBPBB IBBPBB

Figure 1. In this example, the four frames shown in red have been trimmed from a GOP. This causes the I-frames (in orange) to be closer together. When I-frames occur too frequently, the stream data rate can become too great.

MPEG-2 editing myths

The all too frequent claim that during the capture or import of long GOP MPEG-2, it must be converted to a "better" codec is false. All MPEG-2-based formats can, and generally should, be edited natively. Interframe source files require the least storage space and the least disk bandwidth.

Expanding file size during import in no way can improve or preserve image quality. Moreover, native editing typically enables more streams of video to be edited in real time. NLEs obtain YCrCb frames from uncompressed source files, on-the-fly decompressed intraframe source files, and on-the-fly decoded HDV, XDCAM HD, XDCAM EX and XDCAM HD 422 source files. (As part of a decode, 4:2:0 MPEG-2 video is upsampled to 4:2:2.) Therefore, no matter the source format on disk, exports are always made from 4:2:2 uncompressed video.

When you play back a timeline, you are viewing 4:2:2 uncompressed video that is output directly via HD-SDI or HDMI, or converted to RGB. When effects are rendered in real time, the render engine outputs 4:2:2 uncompressed video. When you manually render effects, the render engine's uncompressed 4:2:2 output may either be sent directly to a file or compressed. Obviously, compressed files have the advantage of requiring far less space and typically do not require a RAID-based editing system.

For example, with HD MPEG-2 source video, Avid Xpress Pro HD and Media Composer can render effects to compressed DNxHD files. And, beginning with Apple Final Cut Pro 6, one can request that effects applied to MPEG-2 source video be rendered to ProRes 422 files. Moreover, you can request Apple's Color application to render to ProRes 422 files.

Therefore, clips with applied effects will not be re-encoded to MPEG-2. Likewise, graphics are never encoded to MPEG-2 during editing. The only time MPEG-2 source files will be re-encoded to MPEG-2, or any interframe format, is when you request an export to MPEG-2 or H.264 to create DVD or Blu-ray optical discs.

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I/4	I	I/4	I/4	I/2	I/4	I/4		I/4	I/4	I/2	I	I/4	I
0.36	1.44	0.36	0.36	0.72	0.36	0.36	1	0.36	0.36	0.72	0.3	0.36	1.44
100%	100%						100%						100%

Table 1. A simulation of HD-1 (720p30 HDV) GOP splicing

B		B	B	P	B	B	B		B	B	I	
I/4		I/4	I/4	I/2	I/4	I/4	I/	2	I/4	I/4	I	
	104%											
		B	B	P	B	I	B	B	P	B	I	
0.47	1.39	0.35	0.35	0.69	0.35	1.39	0.35	0.35	0.69	0.35	1.44	
100%	87%										100%	0.61

Table 2. A simulation of HD-1 (720p30 HDV) GOP splicing after removing two frames

frames (in red) have been trimmed from a GOP. While this appears simple, look again at the generated series of three GOPs. You will note the I-frames (in orange) have moved closer together.

I-frames add — relative to P- and B-frames — a huge quantity of data to the data stream. Normally, these I-frame peaks are smoothed by the P- and B-frames that naturally occur before the next I-frame. However, if I-frames occur too frequently, the stream data rate can become too great.

One way to prevent this error, as described in a Sarnoff patent on a broadcast MPEG-2 splicer, is "to adjust the ... levels between the from-stream and to-stream such that ... the resulting spliced transport stream will not suffer overflow, underflow or other undesirable decoder buffer memory behavior." The goal is to decode and encode only GOPs that lie on a splice boundary. The re-encode is controlled by a feedback loop that adjusts encoder compression based upon the current data rate.

Feedback control when splicing GOPs is not only important for HDV that uses CBR encoding, it is also important for XDCAM HD, XDCAM EX and XDCAM HD 422, as well as AVCHD — all of which use VBR encoding. The feedback-controlled process limiting decoding and encoding to only those GOPs that lie on splice boundaries is often called smart GOP splicing.

Simulation of smart GOP splicing

To learn more about smart GOP splicing, I created a simple simulation of HD-1 (720p30 HDV) GOP splicing. In Table 1, the dark and pale blue cells represent two untrimmed,

IBBPBB IBBPBB IBBPBB

becomes

IBBPBB BPBB IBBPBB

Figure 2. Removing an I-frame (in red) would create an illegal GOP (in blue).

six-frame, closed GOPs. The left-most yellow cells represent the last B-frame from the GOP preceding the outgoing GOP. The right-most yellow cells represent the first I-frame of the GOP following the incoming GOP.

Notation within cells indicates that each I-frame is 1.44MB; each P-frame is one-half (I/2) of an I-frame (0.72MB); and each B-frame is one-fourth (I/4) of an I-frame (0.36MB). Therefore, the total data in one GOP is 3.6MB. The bit rate for five GOPs (1 second) is 18Mb/s — the video data rate used by 720p30.

The upper half of Table 2 has the final B-frame of the outgoing GOP and the initial I-frame of the incoming GOP — as represented in Table 1 — trimmed away. The lower half of Table 2 displays the two new five-frame GOPs created by the re-encode process.

Notice the re-encoding process has handled the difficult situation created

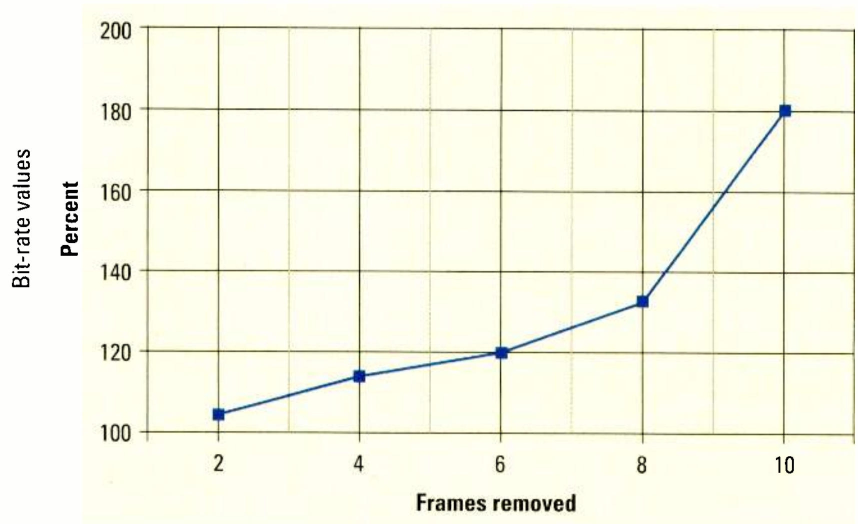

Figure 3. Relative data rate as a function of removing two, four, six, eight and 10 frames from two six-frame GOPs

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- China (Beijing)
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B	I	B	B			B	B	P	B	B	I	
1/4		1/4	1/4	1/2	1/4	1/4	1/4	1/2	1/4	1/4	I	
0.47	1.44	0.36	0.36	0.72	0.36	0.36	0.36	0.72	0.36	0.36	1.44	
	104%											
	I	B	B	P	B	I	B	B	P	B	I	
0.47	1.39	0.35	0.35	0.69	0.35	1.39	0.35	0.35	0.69	0.35	1.44	
100%	87%										100%	0.61

B	I	B	B	P	B	P	B	B	I	
1/4		1/4	1/4	1/2	1/4	1/4	1/2	1/4	I	
0.36	1.44	0.36	0.36	0.72	0.36	0.72	0.36	0.36	1.44	
	113%									
	I	B		P	I	B	B	P	I	
0.36	1.27	0.32	0.32	0.64	1.27	0.32	0.32	0.64	1.44	
100%	71%								100%	0.61

B	I	B	B	P	B	B	I	
1/4	I	1/4	1/4	1/4	1/4	1/2	I	
0.36	1.44	0.36	0.36	0.72	0.36	0.36	1.44	
	120%							
	I	B	B	I	B	B	I	
0.36	1.20	0.30	0.30	1.20	0.30	0.30	1.44	
100%	50%						100%	0.60

B	I	B	B	B	I	
1/4	I	1/4	1/4	1/4	I	
0.36	1.44	0.36	0.36	0.36	1.44	
	132%					
	I	B	I	B	I	
0.36	1.09	0.27	1.09	0.27	1.44	
100%	38%				100%	0.62

B	I	B	I	
1/4	I	1/4	I	
0.36	1.44	0.36	1.44	
	180%			
	I	I	I	
0.36	0.80	0.80	1.44	
100%	22%		100%	0.63

Table 3. Simulated data rate increase above 100 percent as a function of removing two, four, six, eight and 10 frames from two six-frame GOPs

when the I-frame of a GOP is trimmed away. As shown in Figure 2 on page 36, simply removing an I-frame would create an illegal GOP (shown in blue).

Table 2 and Table 3 have bit rate values (shown in red) that indicate the data rate relative to a nominal 18Mb data rate. In Table 2, this value is 104 percent and indicates the increased data rate created by trimming away two frames. Values above 100 percent indicate an overload.

Figure 3 shows data rate increase above 100 percent as a function of removing two, four, six, eight and 10 frames from two six-frame GOPs.

To prevent data rate overload, a smart GOP splicing system, after decoding all frames in a pair of GOPs, encodes them using higher compression. Therefore, the amount of data in each frame is reduced. For example, Table 2 shows I-frame data has been reduced from 1.44MB to 1.39MB.

Table 3 shows the progressive shortening of outgoing and incoming GOPs. In the second example, the final two B-frames of the outgoing GOP plus the initial I- and B-frame of the incoming GOP have been trimmed away.

Table 2 and Table 3 have a value (below the data rate value) that indicates the quality of the two GOPs after re-encoding. As you can see, increased compression causes a relatively significant loss of quality as the pair of GOPs is trimmed shorter. Thankfully, the lowest quality transitions occur at the shortest durations.

The Sarnoff patent addresses this issue by this statement, "With respect to rate control (which ultimately determines overall picture quality of the recoded portion of the transition clip), ... due to masking in the human visual system, a small degradation in

video quality at a scene change is often imperceptible to a viewer."

Given that a six-frame GOP carries 3.6MB, the average amount of data for each frame is 0.60MB. Knowing this value, we can estimate the quality of the frames in the four GOPs centered on the transition. The values in blue cells in Table 3 present average post re-encoding data within the two transition GOPs as well as the preceding and following GOPs. Figure 4 shows these values, in megabytes from Table 3.

port smart GOP splicing, both NLEs typically render effects to DNxHD. Therefore, timeline segments where effects have been applied are no longer interframe video and will need to be encoded.

Second, some NLEs support a less powerful version of a smart GOP splicer. During export, these NLEs scan a timeline looking for those edited clips — with no applied effects — that begin with an I-frame. These clips are marked so they are not decoded and encoded during export. All other clips must be re-encoded. Obviously, these NLEs do not offer the potential of significantly reduced export times.

This type of smart GOP splicing is used by Final Cut Pro when already exported sequences — which inherently begin with an I-frame — are loaded without trimming into a master sequence. This sequence can then be exported without re-encoding.

Third, smart GOP splicing works only when the export codec is the same as the source codec. Obviously, this is the case when HDV-sourced projects are exported to HDV tape. With productions now needing to be burned to optical discs, it might seem the technology would be of less value. However, it continues to be used in several ways.

Some NLEs use smart GOP splicing to burn AVCHD-based red-laser discs from AVCHD source files that were recorded to solid-state media and hard disks. Given the huge computing load imposed when AVCHD is encoded, it helps make this long-GOP format practical to use. Moreover, because smart GOP splicing has value only when the source files are AVCHD, it promotes the support of native AVCHD editing. This in turn eliminates the need to convert AVCHD to a far less storage efficient codec when importing source files. In this way, AVCHD is replicating the history of long-GOP, native MPEG-2 editing.

Professionals who create long-form work, where multiple rough cuts are produced before effects are applied, can also benefit from smart GOP splicing. Rather than distribute rough-cuts on standard-definition tape or DVDs, high-definition MPEG-2 can be burned to optical discs. Red-laser DVD discs can be burned using the BD-5 and BD-9 (double layer) Blu-ray option. (In this case, the MPEG-2 data rate is limited to 25Mb/s, rather than 40Mb/s.) Alternatively, Blu-ray Discs (BDs) can be burned. Both options make use of MPEG-2 as the media codec. And, both types of discs can be played on any BD player. BE

Smart GOP splicing only works when the export codec is the same as the source codec.

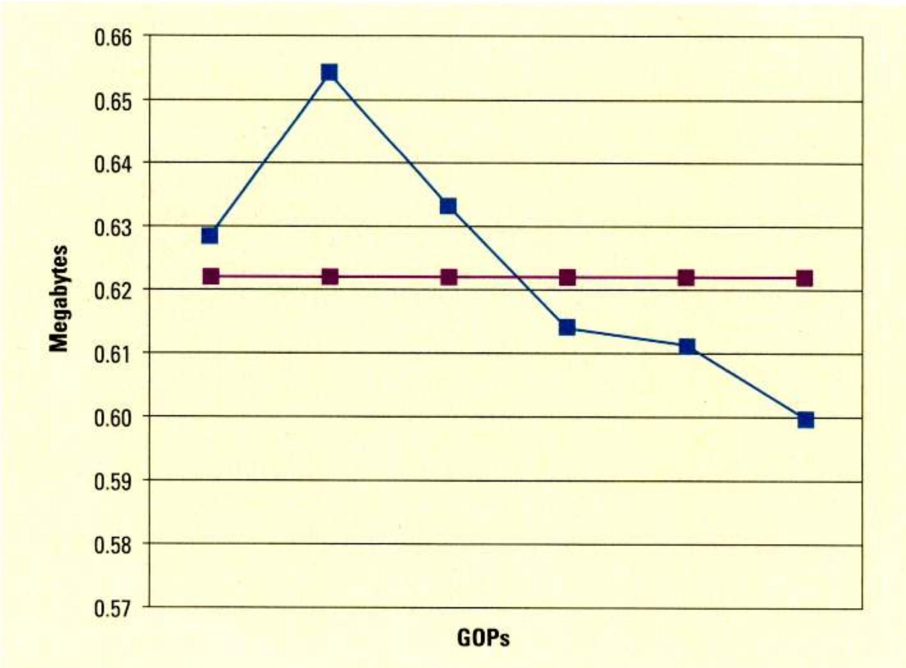

Figure 4. Simulated average data size as a function of removing two, four, six, eight and 10 frames from two six-frame GOPs. Average data size (in purple) is 0.622MB per frame.

Although quality does vary depending on GOP length, average data size (shown in purple) is 0.622MB per frame. When compared to the nominal value of 0.60MB, the result indicates a smart GOP splicer keeps overall quality reasonably consistent for the four GOPs centered on the transition.

Smart GOP splicing restrictions

There are restrictions to using a smart GOP splicer when exporting to MPEG-2 — or any interframe format. First, even though Media Composer and Xpress Pro HD sup-

Steve Mullen is owner of Digital Video Consulting, which provides consulting and conducts seminars on digital video technology.

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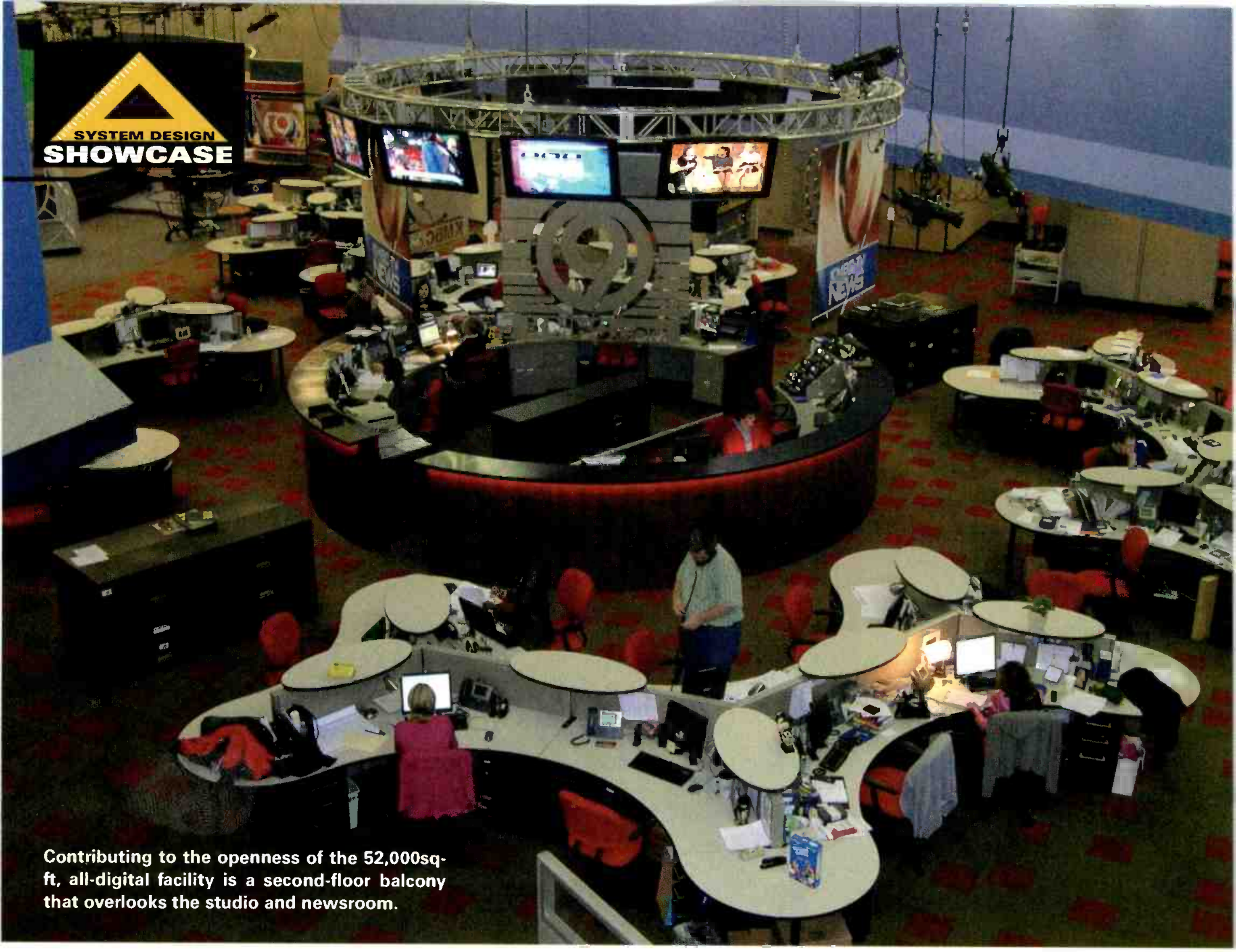

Contributing to the openness of the 52,000sq-ft, all-digital facility is a second-floor balcony that overlooks the studio and newsroom.

KMBC-TV, KCWE-TV offer HD local news from new studio

BY JERRY AGRESTI

Sometimes an organization needs a nudge before it can make progress. That was the case with our stations, KMBC-TV and KCWE-TV, located in Kansas City, MO, owned and operated by Hearst-Argyle. The nudge that caused us to design and build a new technical and studio facility was the expiration of our lease on the Lyric Opera House, the historic structure in which KMBC, the local ABC affiliate, had been located since it began broadcasting more than 60 years ago. It was also where KCWE-TV, a CW network affiliate, joined us in 1996.

Although the Lyric was home for all those years, it was not the ideal location for a television station. Our studio was beneath the opera stage, which is still used for performances, and the technical and business functions were situated on various other fragmented floors in the building, as well as in office spaces in a building across the street. It was not only the facilities' layout that was less than optimal, but also our equipment over time had naturally become outdated. We recognized that the equipment and systems needed to be upgraded to support our transition to high definition.

New digs

In 2002, our team at KMBC/KCWE began working with architects Rees Associates of Oklahoma City, OK, to identify a new location and design a facility that would improve efficiency, provide us a better platform from which to seize opportunities such as those afforded by the Web, and position us for HD operation. Broadcast Building Company handled construction management, and Beck Associates performed the systems integration. Our new purpose-built facility, located in an office park in southeast Kansas City, went on the air in August 2007.

From the new building, KMBC/KCWE now broadcasts three television and two Web channels, including five-and-a-half hours of locally

produced HD news each day along with a 24-hour weather channel, quickcasts and other content for the Web sites. All programming is simulcast in SD and HD. We are proud that KMBC was the first to broadcast its news in HD in Kansas City, which is the No. 31 U.S. television market.

Physically, the layout is approximately 52,000sq ft comprised of two stories. One unusual feature that visitors remember is that the second floor is a mezzanine that overlooks the studio and newsroom. This floor houses the sales, traffic, programming, community affairs, business and executive offices.

The departments directly involved with producing local programming — news, engineering and creative services — are efficiently located on the first floor, where our 4500sq-ft studio flows into the 9000sq-ft newsroom. About 90 percent of the newsroom and all of the technical areas sit on an 18in raised computer floor. The technical core is 841sq ft and currently contains 40 36in-deep racks, with expansion space for an additional eight racks. Production control and audio

The 841sq-ft technical core contains 40 36-in deep racks, with expansion space for an additional eight racks.

Technology at work

ADC patch panels
Autoscript teleprompters
Avid
- AirSpeed ingest and playout servers
- Interplay asset management
- NewsCutter video editing software
- NewsCutters with Adrenaline
- Unity ISIS file system

Canon HJ22x7.6 lenses
Caterpillar generator
Cisco
- Routers
- VoIP phone system

CompuSat automation
Da-Lite Millennium mirror system
DeSisti lighting
EASi satellite dishes
ETC dimmer console and electronics
Evertz
- Fiber equipment
- L-Band router
- MVP multi-image display processor
- VIP multi-image display and monitoring

Harmonic
- 6050 IRDs
- MV45, MV500 and MV100 encoders
- ProStream multiplexers

Harris
- ADC automation
- NEXIO 3600 series server
- NEXIO 3000 series servers

Hearst-Argyle Television HATSAT satellite system
Masstech MassMedia Box digital file ingest
MRC digital microwave
NEC LCD displays
Panasonic
- DVCPRO tape
- Plasmas
- RSP projector

Pathfire digital media management
Powerware 180kVA UPS
SeaChange color engines
Sony
- HDC-1400 cameras
- MVE8000A digital multi-effects processor
- MVS-8000G HD production switcher
- SD-XD cameras

Utah Scientific
- MC-2020 master control processor
- MC-40 master control panel
- UTAH-200 routing switcher
- UTAH-400 routing switcher

Vitec
- 105 pan/tilt heads
- Vinten Radamec Fusion robotic pedestals

Wheatstone D-10 console

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www.360systems.com • servers@360systems.com • Tel (818) 991-0360 • 31355 Agoura Road, Westlake Village CA 91361 take up a total of 865 sq ft, and master control and live ops require about the same amount of space, 861sq ft.

Technical infrastructure

The technical infrastructure of KMBC/KCWE's broadcast facility is built around routing switchers from Utah Scientific — a UTAH-400 (V-288 frame, loaded 3G, HD 176 x 144) and a UTAH-200 (VAA-16 frame analog video and stereo audio 16 x 16). The routers are wrapped with ADC patch panels and Harris DAs. IP connectivity throughout the facility is certified 1Gb/s and is carried over Cat 6E cable. The 10Gb/s backbone connecting the Cisco routers in various IDF rooms is carried over fiber.

Harris ADC automation manages program and interstitial playout through two Utah Scientific MC-2020 master control processors. Both stations are run from a single master control room; program streams are switched using Utah Scientific MC-400 master control panels and electronics. In the course of the design process, chief engineer Ed King and I recognized it would be advantageous to have a master control panel that would optimize flexibility for the operator during breaking news stories. In response, Utah developed the MC-400 panel, which makes it easy for a user to bypass automation control when necessary. Because it's so flexible, we use an MC-400 master control panel as a low-cost emergency backup for our production switcher.

About 90 percent of the newsroom and all of the technical areas sit on an 18in raised computer floor.

Syndicated programming is received via satellite either directly from the syndicator, through Pathfire or from HATSAT, which is Hearst Argyle's program feed center in Orlando, FL. We have a dish farm installed at the station by EASi, consisting of two 7.3m, six 4.5m and four 3.8m dishes. All feeds from the dishes come into the building via Evertz fiber equipment and then are routed to the receivers using an Evertz L-Band router under CompuSat control.

Content is transcoded by a Masstech MassMedia Box and then pushed to Harris NEXIO 4000 series servers and a two-frame SAN with about 460 hours of SD storage. HD playback is through a Harris NEXIO 3600 series server, all under the direction of Harris automation. We are using Harmonic MV500 and MV100

Design team

BBC Construction Management
Beck Associates
FX Group
Gates Service Group
KMBC/KCWE
- Martin Faubell, VP of eng. Hearst-Argyle Television
- Wayne Godsey, president and general mgr., KMBC-TV
- Jerry Agresti, dir. of eng.
- Edward King, chief eng.
- Hank Palmer, IT mgr.
- Jeff Maloney, eng. supervisor

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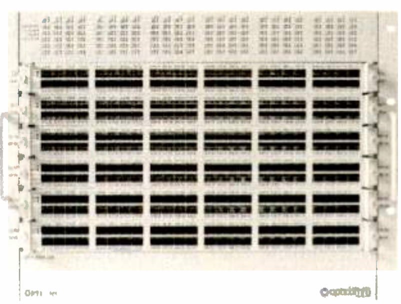

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858.450.0143 | video-sales@emcore.com | www.emcore.com/hc | NASDAQ: EMKR encoders for both HD and SD channels. Once the video is encoded, it is routed to ProStream multiplexers via an IP connection. Presently, most of our broadcasts are in SD, so KMBC and KCWE use an SD master control switcher that enables automated routing of the HD channels. However, that will change to HD-only air paths early in 2009.

Currently, the system generates a combined ASI stream that is sent over an MRC digital microwave and demultiplexed at the transmitter site. This ASI stream is simultaneously sent via fiber to the transmitter as a backup STL. The TSL equipment for returning ENG and city cams to the studio from the tower uses Harmonic MV45 encoders with a ProStream mux combination, and the signal is decoded at the studio using Harmonic 6050 IRDs.

In the studio, we shoot our local news broadcasts in HD 16:9 on five Sony HDC-1400 cameras with Canon HJ22x7.6 lenses and Autoscript teleprompters. Three of the cameras are supported by Vinten Radamec Fusion robotic pedestals, while the other two are stationary pedestals supporting Vitec 105 pan/tilt heads. Camera system control is centered in production control next to the technical director position. A 64-input Sony MVS-8000G HD production switcher and a two-channel MVE800A digital multi-effects processor handle news switching.

News content is shot in the field on Sony SD-XD cameras in 16:9 format. Once at the station, it is ingested by Avid NewsCutters and AirSpeeds through Interplay into a Unity ISIS system. As the stories are edited, they are pushed to AirSpeed DDRs, configured for 1+1 redundancy, for playback to air. Some content is edited in the field, also with NewsCutters, and sent back to the station via microwave. It is then checked into Interplay, stored on the ISIS and pushed to AirSpeed.

For now, all archiving is done on DVCPRO tape, which also provides us with a backup for the news playback system. The KMBC newsroom has six edit cubicles alongside two enclosed Avid edit rooms. Also important to the newsroom, and indeed throughout the station, is a Cisco VoIP phone system managed by a centralized Hearst NOC. The phones are GigE-capable and provide connectivity for the computers and workstations in the newsroom and business cubicle areas. This saved on wiring costs.

Our creative services department also has three Avid NewsCutters with Adrenaline that are connected to the ISIS system. An additional NewsCutter edit station located in the newsroom is used exclusively for news promotion, which is also shot on Sony XD cameras.

In the studio, we have a wide range

HP serves up the clear choice at the right price

In the world of digital news creation, speed is necessary, but reliability and format flexibility are even more crucial. Content producers, looking to install industry-standard platforms that can handle the rigors of daily production while improving productivity, are increasingly turning to Hewlett-Packard (HP) and its family of ProLiant blade servers to achieve their goals. That's because HP's open platform servers, with their IT-centric way of handling data using off-the-shelf components, reduce cost of ownership while ensuring 24/7 reliability.

This new generation of server platforms has changed the way content is managed and stored. For broadcasters and production companies, it has meant increased efficiencies and the ability for a wider range of users to afford shared storage networks that pay for themselves in a year or two.

"Everything has moved to a file-based workflow, and this is something HP understands implicitly," said Stephen McKenna, vice president of the Media & Entertainment division at HP. "Media storage has become just as important as editing software, so HP, with its product lines and computer networking experience, has assumed a larger role in all types of media production installations."

HP continues to target the media space with its ever-expanding lineup of server products by working with key technology partners with an established foothold in the broadcast industry. One such partner is Dalet Digital Media Systems, a provider of news production and asset management systems with more than 100 installed sites worldwide. The two companies recently supplied the main production systems for Warner Bros. Television's syndicated TMZ television show, airing on FOX affiliates.

TMZ offers numerous short video clips during its half-hour program, and represents the new generation of TV newsgathering. One of the challenges of designing and installing a system robust and flexible enough to produce the pioneering rich media TV show was to devise a way to allow the staff to leverage the same fast, flexible and lean production processes it uses to put together content for the TMZ.com Web site. This had to be a collaborative environment that could recognize any incoming format, allow the editors to search and retrieve clips from a large database, and then turn around packages — sometimes minutes before they go to air.

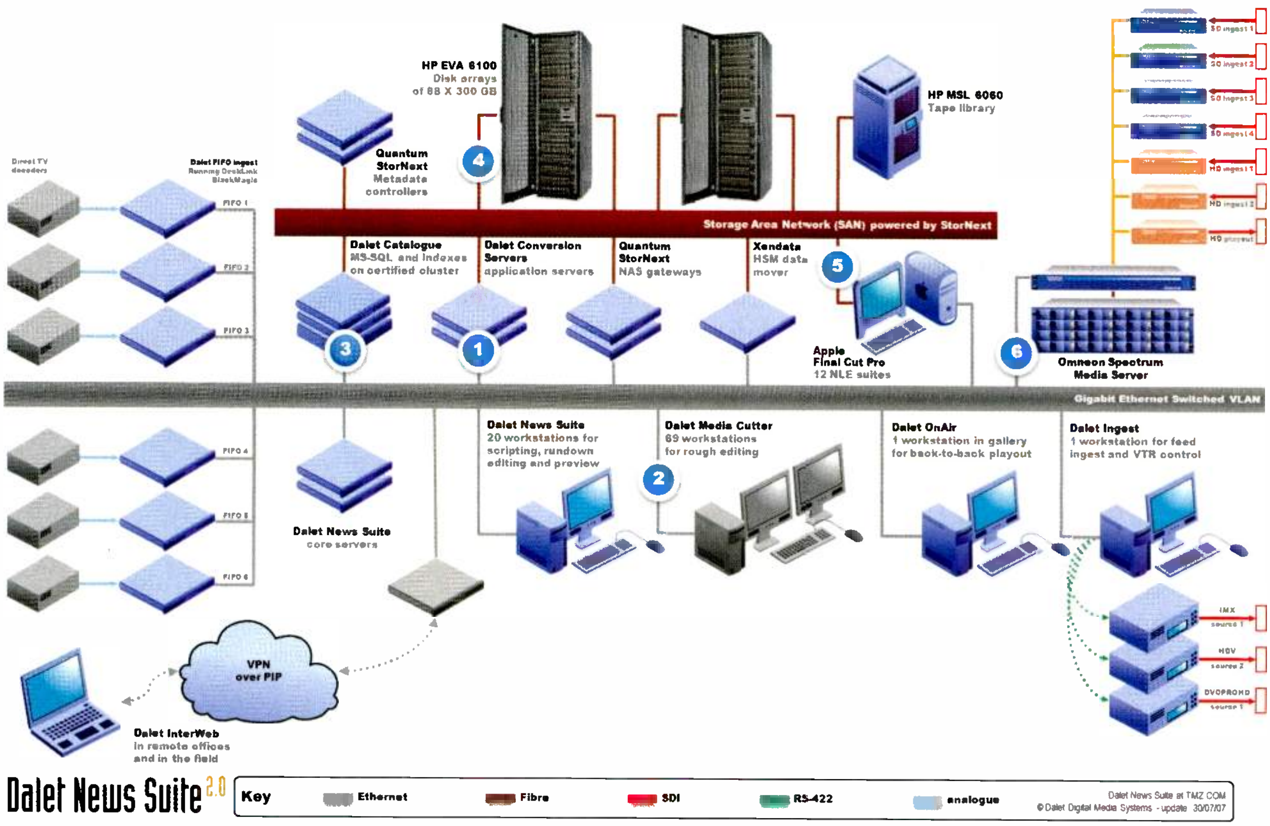
The show's management chose a newsgathering and production system based on the Dalet Plus News Suite and several standard HP ProLiant servers along with an HP storage area network and an HP tape library for archive. Each day, content is ingested and then later quickly located and retrieved from the centralized HP storage. A rough-cut edit decision list (EDL) is generated on a Dalet workstation before it goes onto to a Final Cut Pro editor for HD finishing. The XML EDL instructs the Final Cut Pro editor where to find the original material stored on the HP SAN. Once files are finished, they are sent back through the Dalet system, where a show rundown is created and constantly updated before being played out from an Omneon Spectrum server.

The Dalet Plus News Suite includes a variety of intuitive modules for the creation of stories, including scripts, video and graphics, the operation of the TV show, and the repurposing of content for the Web. This includes such modules as Media Logger, Media Cutter, Rundown Editor, Archiving, On-Air and centralized Ingest. All are used by TMZ staff in one way or another.

One of the key elements of the storage area network infrastructure (with 30TB of capacity) at TMZ is that it accommodates eight of Apple's Final Cut Pro edit workstations working alongside 89 Dalet workstations (often working simultaneously). Quantum Storage Systems' StorNext software works in tandem with HP StorageWorks EVA disk arrays to enable the editors to get material on and off the disc drives very quickly. Now shows contain more material than other entertainment news — because it's right at the editors' fingertips — and are finished faster. In TMZ's universe, like that of the World Wide Web, speed is critical.

months—going from initial installation in mid-July to on air in September 2007. Desbois said it was "the fastest deployment I've ever seen."

TMZ now has the same flexibility you'd find in a news production environment. They can change things on the fly and reorganize a show rundown



different levels of service on the same network, which keeps costs down while still making the content available to anyone on the network who needs it."

As for the HP/Dalet partnership, both parties feel their combined offering facilitates unique, customized

"What makes this type of system interesting is the high level of flexibility and the ability to handle bandwidth intensive HD content quickly," said Benjamin Desbois, general manager of Dalet U.S. "The Dalet platform running on HP servers allows editors and producers to concentrate on the content itself and not the tools used to create that content. This has allowed TMZ to run a very tight ship and produce content before many others in the market."

Another advantage of working with standard platforms is that installation of the equipment usually goes a lot smoother than when outfitting traditional baseband video facilities. For the TMZ project, National TeleConsultants (Glendale, CA) installed the systems in two

at the last minute. Due to the project's success, Warner Bros. also employed the Dalet/HP solution for "The Ellen DeGeneres Show," which leverages HP ProLiant servers and HP storage.

Because the Dalet Plus News Suite is software based, and the HP servers incorporate a modular design, customers can pick and choose the features and modules they need without having to purchase features they don't. This keeps the technology affordable and allows customers to get more for their money.

"The HP servers provide a good platform for collaborative production environments, and we highly recommend them for anyone needing readily available bandwidth for SD and HD content," Dalet's Desbois said. "They can also accommodate

solutions to fit any business model or budget. Cross-platform production is a reality to today's media world, so Dalet and HP have worked hard to developed preconfigured systems that are guaranteed to work together in the real world. The systems they are designing support not only traditional TV but also the Web and new mobile devices. The speed of data management inside the HP servers facilitates a highly productive workflow to make it all possible. It's the clear choice at the right price … and it's available now.

For more information on HP's ProLiant servers for content distribution, visit http://www.hp.com/media/entertainment/.

dalet
Digital Media Systems

hp
invent

of monitors, everything from typical XVGA screens to Panasonic 42in plasmas that use either HD or SD input cards, depending on where they are located on the set. For projection, we have one Panasonic RSP positioned in a corner of the studio with a 114in diagonal screen using a Da-Lite Millennium mirror system. Studio lighting consists of a combination of DeSisti florescent and tungsten fixtures. Some of the fixtures are equipped with SeaChange color engines. The dimmer console and electronics are ETC.

Moving to the production control room, the monitor wall consists of six NEC 46in LCD displays driven by an Evertz MVP system that incorporates both SD and HD inputs. One monitor is for the audio booth, while the other five are in production control. An Evertz VIP system provides redundancy in case of a monitor failure. For audio, we are using a 24-fader Wheatstone D-10 console with three remote analog/digital cage routers.

Power from the local utility comes through a 1600 A main; the entire building is supported by an 800kW Caterpillar generator. A Powerware 180kVA UPS supplies all the power for the tech side, including a clean power drop at all workstations in the newsroom, sales, traffic, executive and engineering offices. To effectively test the generator, we switch the entire building's electrical load over to it at least once a month.

A multi-unit, chilled water system moderates Kansas City's notoriously humid summer temperatures for personnel as well as our equipment. The system offers redundancy or additional cooling when it's required. The air handler unit that services the second floor has been designed so that it can redirect its flow to the tech core in case of an air handler failure.

Conclusion

It seems almost inevitable that you start a project with what seems like plenty of lead time, but in the end there's a rush to the finish. As the end of the lease on the Lyric Opera House loomed in the spring and summer of 2007, crews worked 12- to 14-hour days to ensure that we could vacate the old building and be up and running well before the start of the fall ratings period.

With all hands on deck, we made our deadline, and we continue to be proud of the results. We are confident that our new facility, besides being beautiful to employees and visitors, as well as functional right now, will also have the flexibility to meet our needs well into the future. BE

Jerry Agresti is director of engineering for KMBC/KCWE-TV.

Maintaining QoS

Providing high-quality video over IP is challenging.

BY DAVID GLIDDEN

Originally designed to be opportunistic rather than guaranteed data delivery channels, IP networks have been enhanced to deliver streaming or real-time video services with a high, reliable quality of service (QoS). With such enhancements in place, broadcasters can use IP services for many of their core transport requirements, including digital newsgathering, special event coverage and network distribution feeds.

Broadcasters seeking to improve the QoS of their video-over-IP delivery services should understand the differing approaches to provisioning video services within the IP-related protocols, potential network impairments and emerging methods of improving the QoS of video-over-IP services.

Video-over-IP provisions

In the IP stack established in Request for Comment (RFC) 1122, the Internet Engineering Task Force (IETF) defined a four-layer hierarchy. (See Table 1.) Protocols such as FTP and HTTP are in the application layer. The Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) exist in the transport layer. The IP sits in the Internet layer, and the physical Ethernet connection resides in the link layer.

Layer	Content
Application	FTP, HTTP
Transport	TCP, UDP
Internet	IP
Link	Ethernet

Table 1. The IP four-layer hierarchy as defined by the IETF in RFC 1122

IP is a connectionless or datagram networking service that, by itself, does not provide end-to-end delivery guarantees. IP is not concerned with whether IP datagrams arrive at their destination delayed, damaged, duplicated or at all. Delivery guarantees are the responsibility of the transport and application layers. The IP, however, does provide for addressing, type of service codes, fragmentation and reassembly of data as well as the provision of security information.

Two major methods of QoS when provisioning video-over-IP services are integrated services (IntServ), which allows for specific requests for priority service, and differentiated services (DiffServ), which classifies services by general type.

DiffServ facilitates QoS by providing instructions to routers using the information in the type of service (ToS) field in the IP datagram header. Information in this field, for example, can specify voice-over-IP services, streaming video or non-real-time video, as well as provide differing priorities to each.

Alternatively, the video-over-IP network can use the IntServ architecture to provide a specific QoS for each service flow. IntServ-based networks use the Resource ReSerVation Protocol (RSVP) to ensure that the required network resources are available for the video service.

Multi-Protocol Label Switching (MPLS) facilitates QoS in a packet-switched IP environment by adding a header that includes three bytes for the QoS. MPLS supports both the IntServ and DiffServ architectures.

At the transport layer, either UDP or TCP can be used. UDP is a unidirectional transport protocol that doesn't receive feedback about whether the packets have been successfully received and decoded. However, it can time packet transmission against an external clock, making it useful for real-time audio and video streaming applications. TCP requires feedback in the form of acknowledgment messages, so it enables the reliable transmission of video packets.

Classes of service

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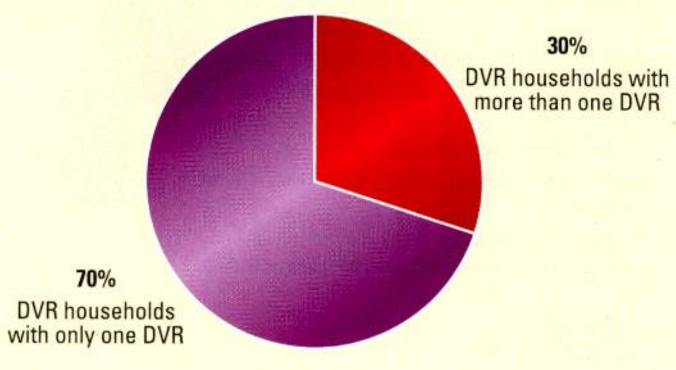

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IP service, broadcasters typically enter into service-level agreements with third-party providers. These agreements specify the minimum or guaranteed levels of network performance, including availability, packet delivery ratio, packet loss ratio, network delay, delay variation, service response time and the time to repair a faulty link.

Priority	Type of traffic
1	Best effort
2	Background
3	Spare
4	Excellent effort
5	Controlled load
6	Video <100ms latency and jitter
7	Voice <10ms latency and jitter
8	Network control

Table 2. The eight priority levels for service, as defined in the IEEE 802.1p standard

The broadcaster will also be concerned about the video (or packet) transmission rate and the class of service. Desirable transmission rates, of course, vary depending on the type of video content being transported and the encoding scheme, with HD MPEG-2 content for network distribution requiring significantly higher transmission rates than SD H.264 content.

IP network providers use classes of service or priority queues to manage the flow of multiple services across their networks. Real-time video traffic should be given a high priority class of service. The IEEE 802.1p standard established eight priority levels for service. (See Table 2.)

Network impairments

Many of the attributes guaranteed in the service level agreement can be measured to demonstrate a specific QoS. These attributes include the network availability percentage and network impairment measures, such as packet loss, packet reordering, network delay, switching delay and jitter.

Packet loss occurs when IP routers receive packets faster than they can forward them onto the network. Packet reordering measures significant impairments in received video quality when packets take different paths and arrive at the receiver in a different order. Network delay measures or specifies the typical amount of time that it takes for packets to move across the network (in milliseconds). In a service level agreement, this average can be specified over a week or month.

Switching delay causes problems with real-time video when a large number of routers in the transmission path create a large traffic queue, while jitter is the variation in the timing of when packets arrive at the destination.

While some jitter is inevitable, it must be minimized in a network design if video is to be successfully decoded and played out in real time. Receivers accommodate jitter by buffering the incoming traffic.

Media delivery index

To improve video-over-IP services, the IETF issued RFC 4445, which specifies a media delivery index (MDI) to determine the quality of the delivered video service. The MDI is calculated through two measurements: delay factor and media loss rate. These two measurements capture many of the network impairments encountered in video-over-IP services.

Delay factor measures the time difference between the arrival of media data and the drain (or playout) of media data, measured for each packet. The delay factor, measured in bytes per second, indicates the amount of jitter that must be accommodated in the receiver buffer. When designing a network, the delay factor will be used to indicate how much latency the network must accommodate to ensure that receive buffers don't underflow from running out of received packets.

Media loss rate counts the number of lost or out-of-order packets over a time interval. Typically, seven 188-byte MPEG transport stream (TS) packets are contained within a single IP packet, so the loss of one IP packet could result in seven lost MPEG TS packets. Because receivers may not be able to reorder packets in the correct order, it is also important to count the number of out-of-order packets as a measure of network performance.

To calculate media loss rate, subtract the actual number of packets received during the measurement interval from the number of packets that were expected, and then scale that calculation to one second. The MDI is the ratio of delay factor (DF) to media loss rate (MLR), displayed as: MDI = DF:MLR. If an MDI equals 90:10, the delay factor is 90ms, and the link lost an average of 10 packets per second.

Testing to ensure QoS

Broadcasters using video-over-IP services can ensure that their services deliver a consistent and effective QoS by capturing and analyzing QoS metrics. An increasing array of commercial test equipment can calculate and display measures like the media loss rate. In addition, broadcasters should ensure that their services are meeting desired QoS levels by using such metrics in the management of their services. BE

David Glidden is an industry consultant and former industry executive.

Achieving ATSC compliance

Keeping up with the A/53, A/52 and A/65 standards will ensure proper signal reception.

BY JOHN WILLKIE

With the dawn of digital-only TV broadcasting just a few months away, full-service broadcasters and digital transmission plants are finally drawing the scrutiny and attention they deserve.Many are finding that encoders and PSIP generators that once were in compliance with all applicable ATSC standards and FCC regulations are now out of compliance, if for no other reason than the underlying standard(s) changed but the equipment did not.

Digital transmission will be your station's sole bread and butter within a few months. As a result, complying with all current ATSC standards and applicable FCC rules is the best, if not only, way to ensure that broadcast signals are usable by all receivers.

Transport stream multiplex

We need to first start with what a transport stream multiplex really is. Whether operating one or three TV stations, broadcasters use one or more transport stream multiplexes to send compressed (retail) signals to viewers in their homes and businesses.

Unlike the limited options permitted with analog broadcasting and its single service per broadcast channel, the multiplex offers a nice toolkit, with just a few rules on how to use it. The ability to place a content stream on any packet ID (PID) carries with it the responsibility to provide viewers with a way to find and process that content stream.

Standards and constraints

The ATSC has published three standards that build upon the MPEG-2 work to create the digital television system used in the United States, Canada, Mexico and other countries. These are the Digital Television, Digital Audio and PSIP standards, known respectively as A/53, A/52 and A/65, each of which the FCC has adopted into its regulations.

MPEG-2 transport streams can include one or more packetized video and audio data elementary streams, which can make up one or more MPEG-2 program services. For receivers to render the elementary streams into a usable TV channel, the transport stream multiplex must include metadata describing where to find elementary streams as well as simple combining directions. Broadcast metadata can generally be thought of as having two classes: signaling metadata (useful mostly to receivers) and announcement metadata (useful mostly to viewers).

ATSC standards used in broadcasting impose constraints on MPEG-2 transport streams.

Fundamentally, ATSC standards used in broadcasting impose constraints on MPEG-2 transport streams. The best-known constraint is "Table 3," which attempted to limit ATSC broadcasters to a handful of video formats. While this is still an A/53 provision, the ATSC has no enforcement powers, and the FCC, which does, has pointedly chosen not to adopt Table 3. So broadcasters are free to use any screen dimension that is evenly divisible by 16.

One ATSC constraint is that each program element is the sole user of each PID. Another key constraint is the encapsulating of analog (CEA-608) and digital (CEA-708) closed-captioning into video elementary streams.

The MPEG-2 specification provides for a program association table (PAT), found in a specific location that signals where to find each of the program map table (PMT) sections that describe the individual virtual channels in the multiplex. While MPEG doesn't specify how often these should be transmitted, A/53 requires that a PAT appear in a transport stream at least once every 100ms, while each PMT section should appear at least once every 400ms. (See Figure 1 on page 58.)

PAT and PMT descriptors

It is important that all entries in the PAT and PMT sections be accurate; otherwise, some receivers may not render a virtual channel or even fail to tune in a multiplex. Each program_number value may be only used once.

Likewise, each PMT section must include the program_number value signaled in the PAT for that virtual channel. Each elementary stream in the transport stream must be listed in at least one PMT section or that stream is unusable.

ATSC A/53 imposes a few often overlooked requirements on the PMT. First, each must include a program

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ATSC packetization characteristics						
Packet ID	Unique PID	t_s_c	a_f_c	p_u_s_i	pointer_field	Listed in MGT
0	True	'00'	'01'	True	0-182	False

ATSC maximums				
ms per section	Sections per program_number	Bytes per section	Instances	Max b/s per PID
400 (ATSC)	1	1024	Current next	80,000

Section syntax			
Syntax	Bit index	# of bits	Mnemonic
table_id	0	8	uimsbf
section_syntax_indicator	8	1	bslbf
'0'	9	1	bslbf
reserved	10	2	bslbf
section_length	12	12	uimsbf
program_number	24	16	uimsbf
reserved	40	2	bslbf
version_number	42	5	uimsbf
current_next_indicator	47	1	bslbf
section_number	48	8	bslbf
last_section_number	56	8	bslbf
reserved	56	3	bslbf
PCR_PID	59	13	uimsbf
reserved	72	4	bslbf
program_info_length	76	12	uimsbf
descriptor()	88	varA	
For i = 0 to N			
stream_type	88 + varA	8	uimsbf
reserved	96 + varA	3	bslbf
elementary_PID	99 + varA	13	uimsbf
reserved	112 + varA	4	bslbf
ES_info_length	116 + varA	12	uimsbf
descriptor()	128 + varA	varA	
Next			
CRC_32		32	rpchof
Note: Bit index is only indicated for the first time through the loop.			

Figure 1. The program map table (PMT) is comprised of sections for each program number represented in a transport stream, each section of which contains the packet ID (PID) and characteristics of each elementary stream in the program service. Image courtesy EtherGuide Systems.

smoothing buffer descriptor. There are two fields in the descriptor: sb_leak_rate, which is the maximum rate for bits leaving the buffer, and sb_size, which signals the size in bytes of the smoothing buffer. While A/53 seems to imply that a value of zero is permitted for both of these fields, such settings would specify a buffer with zero length and no purpose. Typical values for sb_leak_rate are 1000 (signaling 400,000b/s) up to the maximum bit rate for the program, and a typical value for sb_size is 512.

Additionally, when an MPEG-2 video stream is described in the PMT, there must be a data_stream_alignment_descriptor in the element's descriptor loop, with descriptor_length equal to one and alignment_type equal to two (for video_access_unit).

PSIP and MPEG-2

Now, we turn to making sure that the PSIP properly describes the MPEG-2 arrangement. PSIP has a broader context and scope than MPEG-2 PSI (including analog channels), extending up to 128 hours (16 days) into the future, whereas MPEG-2 PSI is about the "here and now."

It is important to note that there is some overlap between MPEG-2 PATs and PMTs and ATSC PSIP, and compliance requires the overlapped data to be consistent. Perhaps most important here is that the MPEG-2 PAT and the PSIP terrestrial virtual channel table (TVCT) both have the same value for transport_stream_id. Otherwise, receiving equipment in homes and at cable TV headends will be fouled up. Of course, the transport_stream_id value must be the one assigned to your station by the FCC.

AC-3 descriptors

Sometimes, consistency even means technically inaccurate. The best example is the AC-3 descriptor, which contains a field that indicates the number of audio channels in an AC-3 stream. So, the thinking goes, that means the AC-3 descriptor must change when an interstitial message

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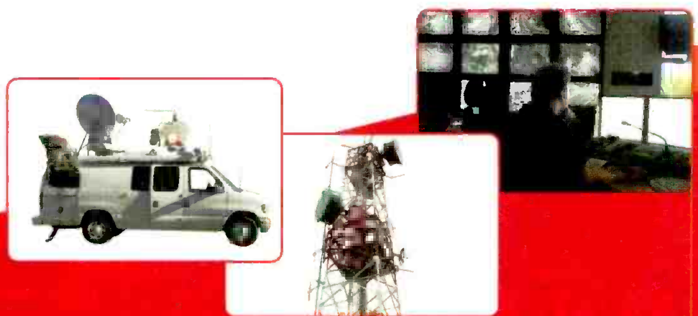

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with only stereo audio airs within a TV program with 5.1 audio. This thinking is incorrect.

The AC-3 descriptor is bound to the concept of a TV program (event), and a message or spot within a program is still part of the program. A/65 provides for the AC-3 descriptor to also appear in the PMT, but that descriptor is still bound to the televised event, because it must have the same values as the AC-3 descriptor in the event information table (EIT).

TVCT descriptors

With some PMT section overlap, the TVCT lists all virtual channels that broadcasters want to inform viewers about. However, the TVCT entry for a channel includes a short name, such as "KGET-DT," and can include information on analog channels. In the receiver, the program_number in a TVCT entry is used to match the entry with the appropriate PMT section, and the source_id is used to link to announced events. TVCT entries cannot have any duplicate source_ids, and the sections must be transmitted at least once every 400ms.

On the redundancy side, the TVCT entry for a digital channel must include the service location descriptor, which duplicates much of the functionality of the PMT for the same channel.

When transmitting a channel description, the channel extended text table (CETT) and its unique PID must be properly listed in the master guide table (MGT), and the ETM_location field must be set to one or two. Otherwise, the CETT won't be associated with the virtual channel in most receivers. Likewise, descriptions of televised events won't be matched up with the appropriate EIT entry unless the ETM_location for the EIT entry is set correctly.

All PSIP tables (except the system time table) must have their summary data listed in the MGT, which should be transmitted at least once every 150ms. And now with an ATSC-compliant transport stream, proudly assert the "GA94" (Grand Alliance '94 or ATSC) registration descriptor, located in PMT sections and the TVCT. Sadly, this registration descriptor is seen more often than true ATSC compliance. BE

John Willkie is the founder of EtherGuide Systems and is a member of the ATSC S1 and SMPTE S22-WG10 subcommittees.

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TV production

BY ANTONIO ARGIBAY, AIA

The television production space, commonly referred to as the studio, is still the primary location for content capture in the television industry. The purpose of this two-part article series is to explain the relationship that the studio has to the other spaces that are necessary for a successful production and to establish technical design criteria for the TV studio you need.

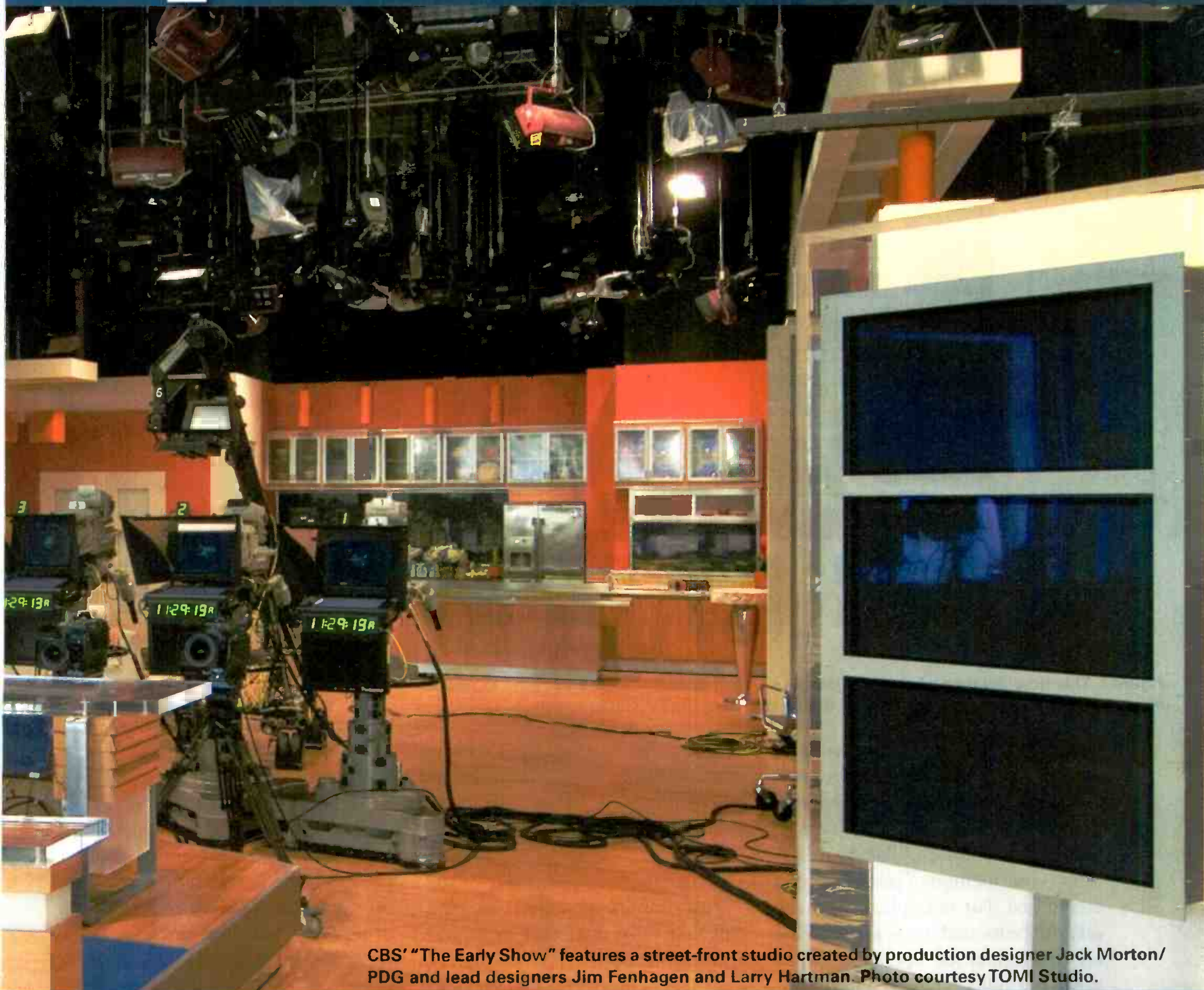
This first article prepares you for the most important aspect of designing a studio — the formative thinking referred to as planning. In addition, it will also discuss architectural systems. Next month's article will cover electrical systems, and ventilation and fire suppression systems. Both articles will contain information to help you understand the relationships among all the systems involved — systems that make a space function as intended.

Why build production spaces?

For designers and architects, the primary question is, "Why build a

spaces

The first article in this two-part series helps you plan TV production areas.



CBS' "The Early Show" features a street-front studio created by production designer Jack Morton/ PDG and lead designers Jim Fenhagen and Larry Hartman. Photo courtesy TOMI Studio.

studio for content capture at all, when, today, more and more content is captured outside the conventional studio environment?" Using this question as a starting point to determine the requirements for the studio space you are considering is critical to successful planning. You will be surprised by the variety of reasons people have, some as banal as wanting to have a space that looks like a television studio in order to retain funding. Others may want to create speculative, flexible space because they happen to own a large space with high ceilings, or there may be a need to accommodate a new production with specific requirements. Then there's the obvious — the need to plan a production studio that will streamline the production process and provide the most efficient workplace for the type of production you envision.

The process

The planning process for spaces should always begin with a mission statement, success criteria or a charter — some device that can be used to evaluate all of the steps in the process to ensure that they are consistent and moving toward the final goals.

The second document you need is an architectural program. This document outlines the quantitative (dimensions and areas of all the required spaces and a circulation factor of between 25 percent and 35 percent) and the qualitative aspects and requirements. It should address functionality in terms of the type of production foreseen. Asking questions is one method of getting criteria established. For example, how many sets will be located in the space? What are the hours of operation? How much flexibility is required to accommodate the show's format? How often will the set change?

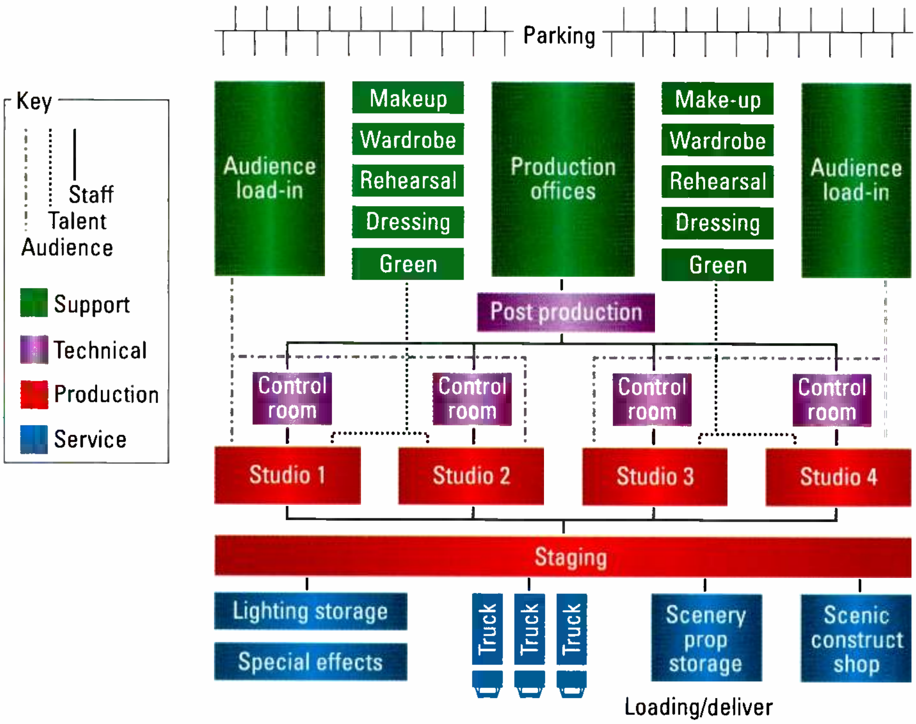


Figure 1. This flow diagram shows the people vs. stuff concept, where the flow of people needs to be separated from the flow of things that feed the TV studio space.

TV production facilities vs. TV studios

The TV studio itself is part of a larger organism — the television production facility. While a TV studio is the primary source of content capture, its existence and functionality are totally dependent on its relationships to the adjacent support spaces.

The most critical aspect of planning those relationships is the control of circulation. Having evaluated many facilities over the years, Meridian Design has observed that the flow of people — talent, support and technical — has to be separate from the flow of things that feed the TV studio space — things like scenery, lifts and other equipment. We call this people vs. stuff. (See Figure 1.)

The people side

This important aspect of planning has to be modified to fit your production needs. For example, a soap opera's production flow is much more demanding in terms of scenery movement than that of a news operation, even though both are daily occurrences. The size of your existing or planned facility is also important and must be taken into account. The concept, however, stays the same; only the scale of the application differs.

Staying with the people spaces, let's consider organizational categories that will help define proximities. In the diagram for the spaces to be occupied, there are two categories: technical and support.

The technical spaces are defined as those required for the personnel and equipment needed to capture the production's images and audio. These spaces typically include video control, audio control, graphics, equipment racks rooms and other similar spaces, all of which are critical aspects of production, even if provided in a mobile unit.

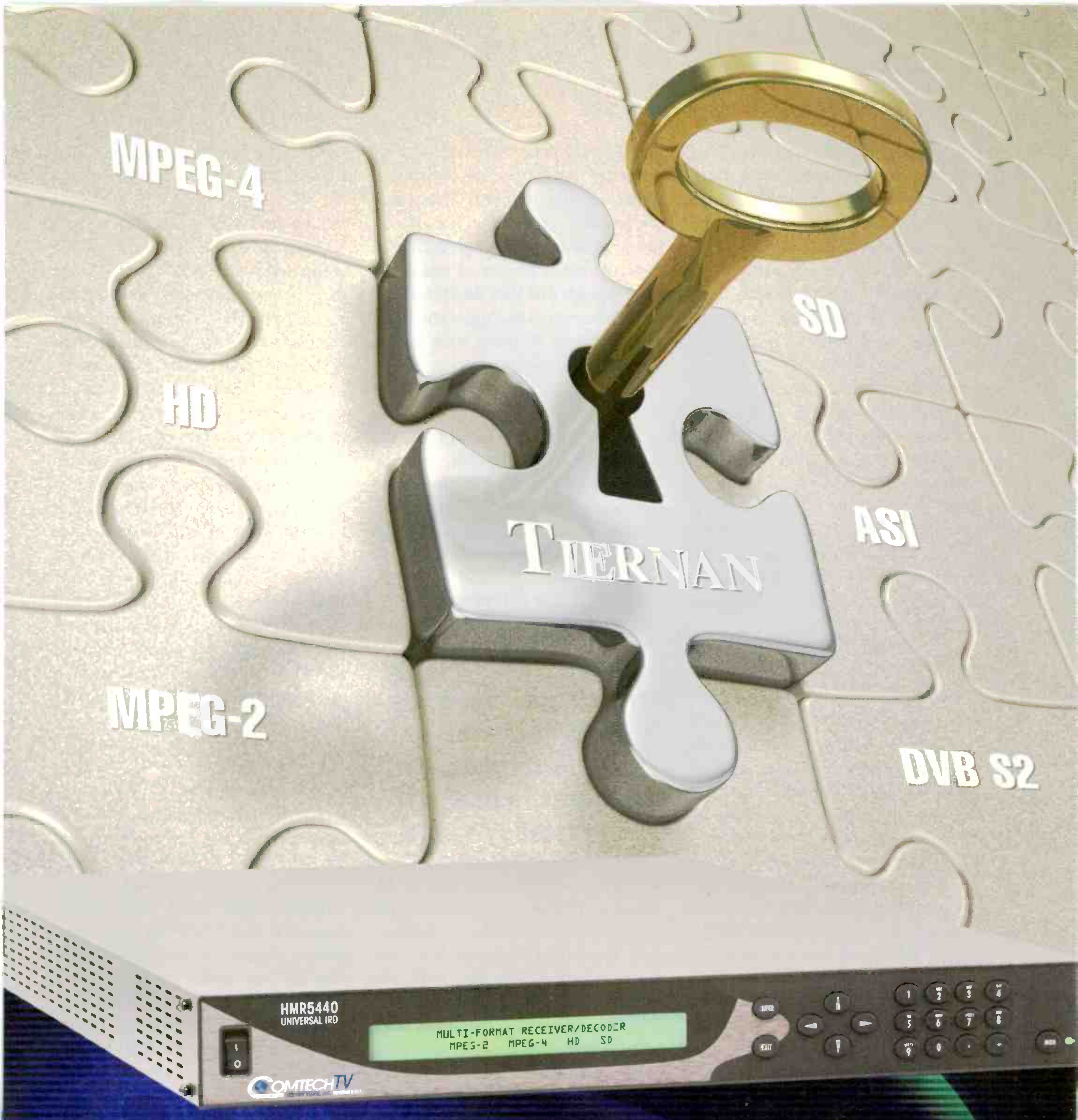
The support spaces are required for the people working on the production so they can come together and do their part in an organized, coherent manner. Two primary groups of people are production staff, who have largely administrative tasks and work in offices, and talent-related personnel, who occupy a variety of rooms, such as wardrobe, green rooms, hair and makeup, rehearsal, and dressing rooms. A third group, the audience, is present in some cases as a requirement or a possibility in the future.

The final consideration on the people side is the need for spaces that support their needs — a place for them to eat conveniently and efficiently in large groups, as well as bathrooms in greater quantity than normally provided for office occupancy. This is because their use is peak-driven. Everybody has a short time to use the facilities, and they need them without delay.

Once you have grasped these requirements for the planned facility, you can begin to plan the desired sizes for the spaces. This is a critical aspect of planning, because every space has a range of sizes. Whether for technical or support, a minimum area is required to perform functions adequately. Variations outside this range are either wasteful, inefficient or, in the worst-case scenario, nonoperational.

The stuff side

The stuff side of the diagram represents all the materials that flow in and out of the studio space. The spaces are characterized primarily by their access to loading, scenery construction or storage, lighting shops



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(storage and maintenance), grips/cables storage and staging areas. Many times, these areas are provided with electrical vehicles for moving scenery carts and with lifts to access high areas of the studios, requiring parking, charging and maintenance areas. Additionally, the stuff side is operated by people who need support spaces of their own, such as locker rooms, bathrooms and break space.

The stuff spaces require a size analysis in order to determine how much space will be devoted to each function and each production requirement. A telenovela or soap opera is much more scenery-intensive than a sitcom, which is much more scenery-intensive than a talk show; therefore, the staging area must be designed accordingly.

Nonhabitable spaces

Considerations other than those of occupied spaces are the location and relationship of spaces related to the mechanical and electrical systems, which allow the TV studio space (and technical support areas) to function. Their location and size are major considerations in planning the space. The future flexibility of the spaces surrounding the studio, as well as short-term initial cost and functionality, is greatly influenced by a coherent design of the mechanical and electrical systems. It is for this reason that we always install those systems on the level above the studio floor.

Air-conditioning equipment is a key component of a television production facility. Many times in existing facilities, a lack of planning leads to less than optimal installations, resulting in noisy, nonintegrated and wasteful systems that are costly to operate. Our recommendation is always to have this equipment indoors, because rooftop fan-unit equipment is left exposed and is less likely to be maintained. A minimum of 50 percent of the TV studio area should be matched for air-conditioning (100 percent if redundancy is required) and 25 percent for power and lighting. Similar allowances should be made for mechanical and electrical spaces serving technical areas, such as those described above. These facilities need to be far enough away that they are not a source of noise but close enough that they don't require a costly investment in copper and ductwork in order to make your facility function adequately.

Flexibility and permanence

There are many reasons to design facilities that are flexible, such as changing of technology, production techniques and even format. To this end, it is important to realize that a TV studio is permanent, and its flexibility depends on how it is designed and located within the overall facility, whether it is new or existing.

> **The future flexibility of the spaces surrounding the studio is greatly influenced by a coherent design of the mechanical and electrical systems.**

At the core of its design is its size. We recommend that you build the largest possible studio for the production you envision. That being said, here are some average sizes for a one- or two-position studio:

- 3000sq ft to 4000sq ft for news;
- 4000sq ft to 6000sq ft or more for a production shooting at opposite ends of the studio;
- 8000sq ft to 12,500sq ft and larger for a soap opera.

Studio heights will increase proportionally with the size of the studio. A small studio should have a minimum clear height (excluding everything but lighting) of 15ft, a medium studio 25ft and a large studio 35ft. A minimum width of 45ft is recommended for smaller studios and 100ft for larger studios, as this allows shooting to both sides along the long sides of the studio.

Architectural systems

All of the components and systems integrated to create a TV studio are there for a reason and are practical by nature. The architect is generally responsible for acoustics, finishes, egress and general code compliance.

When taken individually, these components and systems, which make up the entirety of a TV studio, are all, in one way or another, multidisciplinary. There is a danger in formulating a design without having an understanding of how these systems are interrelated. It's critical to have an architect who is equipped with visualization tools, 3-D capabilities and acoustical understanding, along with the structural, ventilation, electrical and fire-suppression experience that is necessary to weave together the required elements.

The conductor of the orchestra

The preparation and planning of the project details must be executed in the right order and in the correct proportion to achieve a successful project implementation phase. One guiding concept is that of the orchestra conductor, wherein the architect responsible for the overall project carefully weaves together the different disciplines represented by the other consultants and does so in the right balance in order to achieve a coherent, evenly planned project.

However, the architect is no mere coordinator. He is responsible for the critical systems in all projects and acoustics. In similar manner, the finishes, most importantly those of the TV studio floor, are key for any designer and builder of a TV studio. Additionally, every component that is integrated into a studio has an architectural element that is characterized by size, weight and physical properties. These are a key concern for planning, dimensioning and coordinating the construction. Finally, the architect is the critical player in planning the structural requirements and their integration with the systems they support. This includes adequate structure for the long spans, supports for rigging, catwalks and penetrations into the studio space.

Acoustics

In all TV studio projects, acoustics is a key issue. Two primary areas are critical to the project's success: room response and sound transmission. The first focuses on how the room will respond to sounds. In most TV studios, this is not a particularly complicated matter. However, if the content creation space contains glass (such as in a street-front studio), reflections need to be controlled. The second area focuses on the design of an envelope that will block sound from entering and leaving the space. If you did your homework correctly, you will have already established design criteria for acoustics in the programming phase.

Room response

Room response is affected primarily by the ability of surfaces to absorb or diffuse sound and by the proportions and geometry of the room. Generally speaking, TV studios are designed to be acoustically dead, with little reverberation time. This is usually achieved simply by providing absorbent materials in all possible surfaces, with the exception of the floor. The material typically used is rigid fiberglass boards that have been covered with a surface treatment to prevent fraying. However, with recent emphasis on the use of green products, recycled cotton fibers properly treated for fire retardation are becoming more desirable, albeit costlier.

In small- and medium-sized studios, there are two reasons that set elements can be problematic if the production designer fails to consult with acoustical experts on the project. First, the set in a small studio occupies proportionally more space, thus being more acoustically significant. Second, shiny, hard, reflective surfaces look great on camera but perform poorly acoustically.

The proportions of the TV studio are of some concern, and the smaller the studio, the greater the concern. Most studios are used primarily for voice purposes. However, if the studio is frequently used for music, particular attention should be paid to proportions, as they are responsible for resonant room modes. If music is part of the daily routine, such as in variety shows, or if there is an audience, room acoustics, in general, become more important. While a detailed discussion is beyond the scope of this article, note that the preferred proportions, when viewed in plan or in cross-section, are nonmultiples of each other. A cube shape, for example, is the worst. Dimensions containing integer multiples, such as 20 units wide by 40 units long by 10 units tall, are problematic. The acoustical consultant should be actively involved early in the determination of room size.

Sound transmission

Sound transmission is the ability of the construction (which defines the production space) to diminish the amount of sound energy transmitted through it, either as an external source or as an internal source. The objective is to design the systems that enclose the studio so that the space can function adequately without interruption by outside noise sources and so that the events in the studio don't disturb other studios or spaces nearby.

Acoustical considerations

We often refer to links in the chain as an analogy of the system we need to design. Doors, walls, floors and ceilings have to be designed to function at the same level. If one element is underspecified and forces the whole system to function below expectations at that level, the resultant underspending in one area leads to potential overspending in the other systems. An acoustical consultant should be engaged as part of the team to provide measurements, establish criteria and recommend systems that are in balance.

The final acoustical consideration is the noise generated by the air-conditioning/ventilating system, which is the biggest source of noise within your space, once the proper isolation is in place. The two sources of noise related to ventilation are equipment noise and air noise at point of discharge.

Studio floor

The studio floor is one of the most important components that make up a studio. Without the necessary degree of floor level, cameras will roll by themselves, causing uneven images. If the floor contains bumps and imperfections, the camera will move abruptly as it hits mounds and valleys. These two aspects of the TV floor are referred to as level and true-to-edge. Typically the level is a maximum 0.25in over a distance of 50ft. True-to-edge is the local flatness of any given area, which should typically not exceed 0.0625in, the maximum gap in any part between the floor and a metal straight-edge. A good way to inspect this is with a long, straight metal tube. Shine a light behind it to look for gaps and measure them with thin plastic, such as a credit card. If the card fits under the tube, the floor level is unacceptable.

Most floors are cast in concrete, a material that cannot achieve those tolerances. So how do we surmount this problem? To do that, turn to self-leveling concrete toppings or troweled, cementitious toppings. In selecting a solution, it is best to know how the floor will be finished by scenic elements (vinyl tile, wood, epoxy paint, back-painted plastic sheets, etc.). Some self-leveling toppings, however, can be used as a finished high-gloss floor (Stonlux). Others, such as Ardex, are self-leveling but may require grinding to meet the flatness criteria and are not finished floors. In the U.S. market, Dexotex is the better known manufacturer of hand-troweled finished floors.

Not all production environments are suited for a concrete finished floor, due to its inability to accept nails used to secure scenic elements that are often made of wood. In those instances, you could use floors made from medium density fiberboard (MDF). The installation of this material, an organic material that absorbs moisture, must be carefully coordinated with the moisture level in the concrete. It is typically installed in a staggered pattern over a series of level, water-sealed wood strips spaced 16in on center, with the void between the strips filled with cement. It is best to spline the edges of one board to the other to ensure the floor level from one to the other, and then finish the flooring system with a light sanding.

Finally, the structure of the floor has to be taken into consideration. It should always be decoupled from the adjacent floor slabs. If the studio is at ground level (and there are no recurring impact noises that shake the ground), it will suffice to provide a joint between the studio slab and others adjacent to it. In other cases, such as in studios with occupied spaces below and in situations where it isn't structurally feasible to separate adjacent slabs, a floated floor is the only solution to ensure isolation from airborne and structure-borne noise, such as vibrations and impact noise like hammering.

The two primary types of floated floors and methods of building them are spring-isolated and resilient-mounted. The spring-isolated floor consists of a steel-reinforced concrete slab cast on top of the structural slab, with isolators spaced along its extents at even intervals, typically 4ft. After a minimum of seven days of curing, the slab is jacked up by turning spring-tightening screws from above the slab. This solution is relatively expensive and, for optimum performance, should be specified only through close coordination with the structural engineer and the acoustician.

The resilient-mounted system is less expensive, does not require jacking up and requires less curing time but is more limited acoustically, providing largely structural decoupling. Typically, it is a system of neoprene or resin-covered fiberglass cubes covered with plywood and has a concrete slab poured over it, with only minimal mesh-type reinforcement. Both systems should be specified by the acoustical consultant based on the specific project requirements.

Wall construction

The wall system in a studio provides lateral acoustical protection from adjacent spaces. (See Figure 2.) Additionally, the walls provide places on which to secure scenic elements that are usually tied above or on the

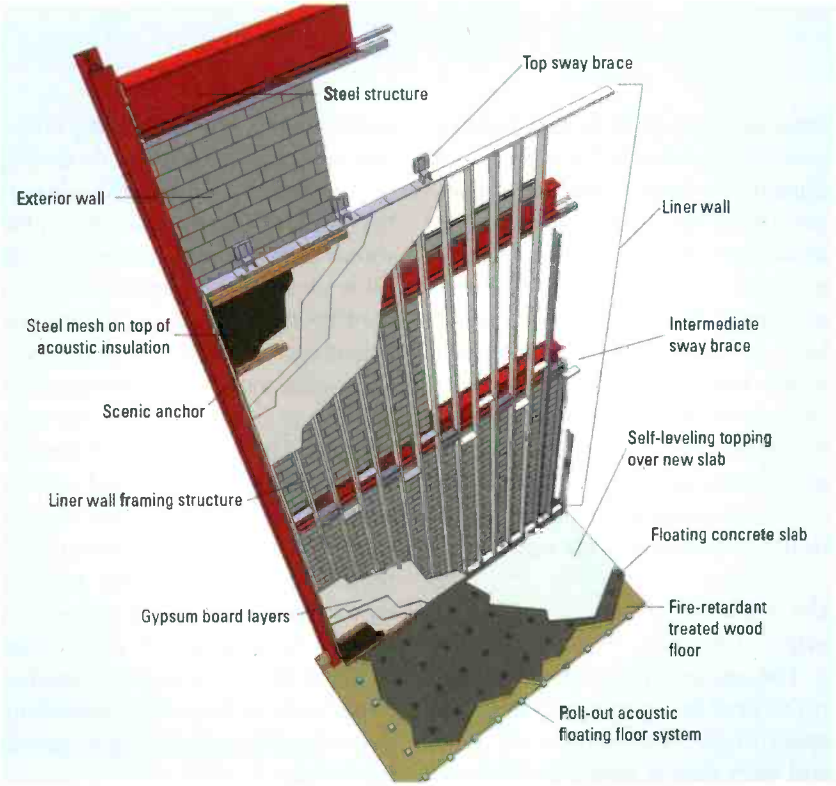

Figure 2. An acoustically isolated wall and floor construction are important when designing a TV studio. The wall system provides lateral acoustical protection from adjacent spaces.

studio floor and braced laterally to the wall. They are also treated with absorbent material to deaden the sound in the room.

Typically, studio walls are built of two walls that are, ideally, completely independent. This decoupling of walls is a primary requirement for acoustical isolation and is simple in concept. However, it is more difficult in practice, especially if it is a high wall. This double wall is designed so that the outer wall of the studio extends from the floor to the underside of the structure and is tightly sealed where penetrated by ducts, conduits and other structural members. The inner wall is built on the isolated or decoupled floor slab to ensure it will not vibrate along with the unisolated structure. This separation further ensures that impact on the outer wall will not be transmitted structurally.

It is not unusual to build the outer

wall with concrete masonry units for larger TV studios, as the outer wall may be the outside wall of the building itself. However, usually — especially in the smaller to medium-sized studios — the wall is made of steel studs, with multiple layers of gypsum board on each side, as required to meet the acoustic design criteria. The cavity between the gypsum boards is then filled with fiberglass or mineral wool for cavity absorption.

The interior wall, often referred to as the liner wall, is almost always made with multiple layers of gypsum board on the studio side and fastened to metal framing, with the cavity filled with fiberglass or mineral wool for absorption. The inner wall, unlike the outer wall, is unfastened at the top. It must remain independent of the structure to maintain isolation, and, as such, is unstable structurally. The inner wall maintains structural integrity by lateral isolators called sway braces. There is a large variety of products that are designed to restrain lateral movement of the inner wall. Generally, these products are attached to the outer wall by means of a neoprene cushion that prevents a hard connection between the two walls.

It is important to note that when designing tall walls, special consideration must be given to structural requirements, such as the ratio of wall thickness to height, location of isolators (when required) and their coordination with support points for rigging. As mentioned above, the walls are largely finished with soft, absorbent materials, which are then protected with an inexpensive material such as wire mesh. However, this wall treatment must be interrupted at frequent intervals with the installation of horizontal wood members that can be used where screws are needed.

Doors and other wall openings

The weakest link in the wall system is the need for openings to make the space usable. The number of doors and their sizes is determined by several factors. All doors are there for a purpose and fall into one of two categories: doors for people to use and large doors commonly known as elephant doors.

Depending on studio size and use, people doors are placed in convenient locations in quantities necessary to satisfy safe egress. Studios that have audiences require specific planning so that they have enough doors to handle the occupancy and take into consideration the distance from the audience to the doors. Others need only one or two entrances for people, depending on the size — one typically close to the support spaces, such as control rooms and dressing rooms, and the other close to the staging area to be used by stage hands and technicians who access the studio. Elephant doors are used to move scenic elements into and out of the studio from the staging area. The smallest recommended size is 10ft x 6ft, typically used in small production spaces that have infrequent changes of scenery or don't require movement of tall sets and motor vehicles. A more appropriate size for those studios is a minimum of 12ft x 8ft. For specialized productions, such as those for filmmaking, doors should be much larger than the minimum.

When doors are opened, outside noise immediately penetrates the studio space. While sometimes this is not acceptable, it is at least manageable. In such cases, the door should be a true acoustic door with a sound transmission coefficient (STC) of at least 51, which, while it will not protect from somebody knocking (impact), will give substantial protection against airborne sound. We recommend using two doors of lesser quality to create a vestibule, or sound lock, which offers the best protection.

Sound locks for elephant doors are impractical due to space constraints. In smaller doors, up to 12ft x 8ft, it is practical to provide one set of doors on the outside wall and another on the inside wall, thus creating a zero clearance sound lock. Doors larger than that become increasingly heavy and need systems to mechanically aid their operation. The more popular doors are motorized, sliding or vertical-lift doors with cores of 4in to 6in, partially filled with concrete or other mass-producing component, depending on the desired STC rating.

Other openings that should not be overlooked are those that bring in wires for power and broadcast. Typically, power is brought inside in conduits or electrical wire-ways. These materials must be interrupted so that the rigid conduit does not bridge the independent walls or make a hard connection between the two. To eliminate bridging the walls, it is necessary to use a flexible conduit through the penetration, including proper grounding to ensure continuous ground for the power system. The broadcast wiring is usually in a cable tray in order to provide quick and easy access to the substantial amount of wiring. The cable tray should be stopped at either side of the wall, allowing the wires to penetrate through a metal box or conduit that is filled with easily removable, compressible material that seals the opening.

Ceiling systems

The space between the ceiling structural slab and the bottom of the lighting grid is by far the most complex coordination challenge in a TV studio. Here, one must interweave the HVAC distribution, acoustical absorption and isolation, electrical distribution, production lighting support and control systems, and rigging points for scenic elements, as well as the structural elements of the long-span studio roof. (See Figure 3 on page 73.) The art in the design of this area is all about coordination of the many design professionals and trades people responsible for the various systems. Informed by the client's production requirements, it is the architect's responsibility to perform this coordination during the design process, and it is the general contractor's responsibility during the construction phase.

Some of the issues related to the ceiling will be covered in next month's article. However, issues such as lighting support systems and air distribution, which are future topics, have architectural, structural and acoustical implications, so some of those issues are worth mentioning now.

TV studios need wide open

A lighting system supported by catwalks requires an extra 30lbs per sq ft in terms of load requirements.

spaces without columns. Structurally, that implies long beams to span the space. Many times in my career, clients have enthusiastically shown me an existing large warehouse space, free of columns, only to find that that roof would have to be heavily reinforced at a substantial cost. This is because structures are typically designed to fulfill specific needs. A warehouse roof is designed to keep the rain out, whereas a TV studio roof has to carry a much greater load, in addition to the rain. That load can vary, depending on the size of the studio, the lighting supports strategies and the acoustical isolation to be hung from it.

Small studios are usually much less affected, because the spans are smaller. As studios become larger, such as those used for telenovelas, soap operas, audience variety shows and sitcoms, the weight-to-span ratio increases exponentially, meaning more weight in longer spans. In planning the studio as new construction, there is a benefit to being able to incorporate the structural components efficiently. Add allowances above code requirements for designs, including the following distributed loads: 7lbs per sq ft for acoustical isolation; 35lbs per sq ft for ducts; electrical and piping, and 25lbs per sq ft for the lighting and grid.

If you choose to use a lighting support system based on catwalks, another 30lbs per sq ft should be added. That puts the requirement somewhere between 67lbs and 97lbs per sq ft. We also recommend structural provisions for concentrated loads, as often productions need to hang heavy elements. The amount depends on the size of the studio. We typically plan for suspending a weight of 3000lbs from the areas dedicated to concentrated loads.

In large studios, there is typically a structural steel subframe below the acoustical barrier ceiling from which all other elements are hung. It is impractical to create a studio in which the structure is buried behind layers of acoustical construction. The subframe usually is made of steel beams 10in deep, creating a grid of 10ft to 12ft hung directly from the primary structure.

Ceiling considerations

The ceiling is the surface that completes the acoustical enclosure of the studio. In most cases, whether you have another occupied floor above you or just a roof, an isolated ceiling is necessary to maintain the acoustical standards established in the design criteria. The amount of mass and the qualities of the acoustical ceiling are subject to the recommendations of the acoustical consultant and can vary from a hung acoustic tile ceiling to a multilayer gypsum board ceiling. The ceiling, however, is always installed up to the interior wall of the studio and is never attached, allowing independent movement.

Often a ceiling has a layer of plywood and one layer or more of gypsum board, if required. Then the ceiling is suspended with a spring neoprene isolator. The isolators are typically located in two directions at 48in on center. Over the years, plywood has proven to be a practical material for the attachment of small speakers and to make the installation of the gypsum board more secure. Above the ceiling, it is important to provide a minimum of 6in fiberglass

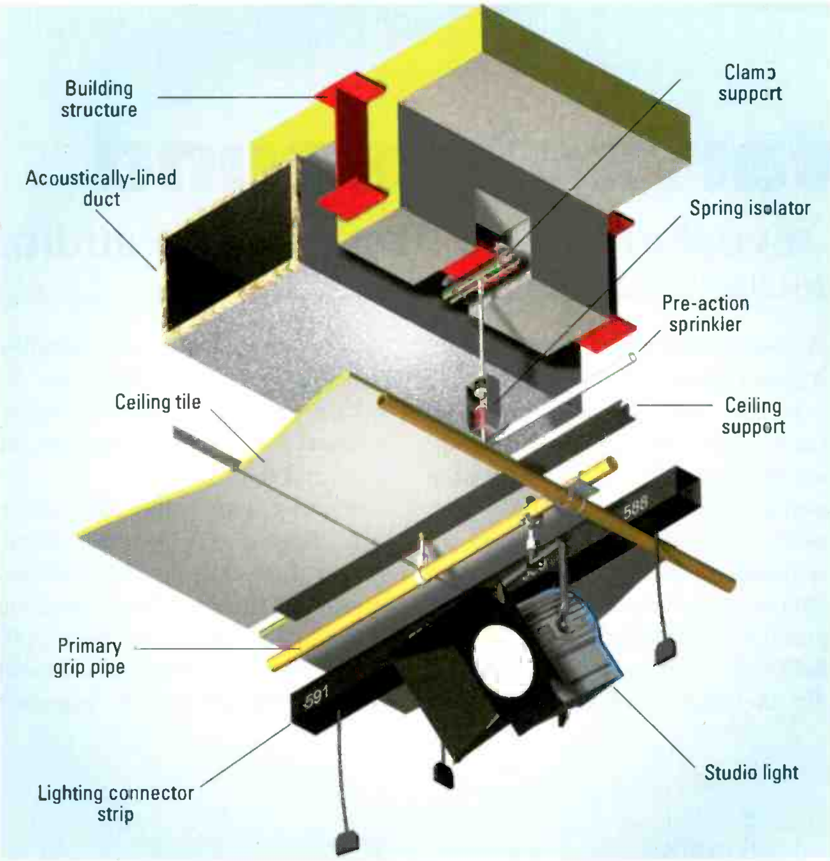

Figure 3. CNN studio ceiling detail

batt insulation to absorb sounds in the cavity. Below the ceiling, it is recommended that a minimum of 2in of absorbent material be installed.

The architect must work with the ventilation engineers and others to carefully coordinate the location of the isolators and the ducts. We usually create one drawing to show those locations, plus two more drawings to document the other ceiling information, because showing it all in one drawing creates clutter, making it impossible to read.

The ceiling area of a TV studio is congested, offers many challenges and has to be specifically tailored to the desired size and planned production needs. Many of the systems in this area will be covered in next month's article, which will review electrical systems lighting, power and systems integration (low voltage). BE

Antonio Argibay, AIA, is a principal of Meridian Design.

Time Warner's sound

A study with Dolby revealed how to best manage audio.

BY IVAN LARSEN AND JEFFREY RIEDMILLER

Time Warner Cable currently serves more than 8.5 million digital video subscribers and provides an enormous amount of programming to its customers. As the cable industry continues to evolve and new digital tools become available, companies such as Time Warner Cable need to refine the way they ingest audio content. To this end, the cable company recently completed a study on how to best maintain consistency of audio levels across programming, commercials, local ad spots and other inserted content.

Time Warner Cable Media Sales' Southwest Region Operations Center teamed with Dolby in conducting a test focused on its ingestion of digital content. This particular operations center supports more than 230 insertion servers, with five cable multiple system operator (MSO) partners. It also maintains more than 25 physical insertion locations, ingests about 1000 pieces of content weekly, and inserts and monitors content on more than 2450 channels. It manages designated market areas (DMAs) in Colorado, Kansas, Nebraska and Texas, which comprised the testing region.

The study targeted digital program ad insertion applications, which total more than a quarter million ad inserts daily. The study focused on the proper use of dialog normalization to improve subscriber experience, and both real-time and non-real-time (file-based) system components were considered. First, the provisioning practices of local (headend) digital simulcast encoders was investigated by analyzing content over which local control was possible (via the dialog normalization value and incoming loudness levels with baseband signals). Also considered were loudness levels of pass-through services (for which local control is not possible).

A snapshot of ingest content

In the study, 18,695 commercial ad spot files were analyzed, and among these files (all of which were stereo audio), 500,000 data points were collected. The file-based ad spot content used MPEG-1 LII audio almost exclusively at the acquisition point. Unlike Dolby Digital content, MPEG-1 LII does not contain audio metadata (and therefore, does not contain a dialog normalization metadata parameter that the decoder can use to maintain consistent loudness levels among programs, ad spots, and so on).

Working with Dolby, the Southwest Region Operations Center refined their existing file-based approach that included the deployment of the Dolby DP600 program optimizer. Simple workflow adjustments to Time Warner Cable's approach

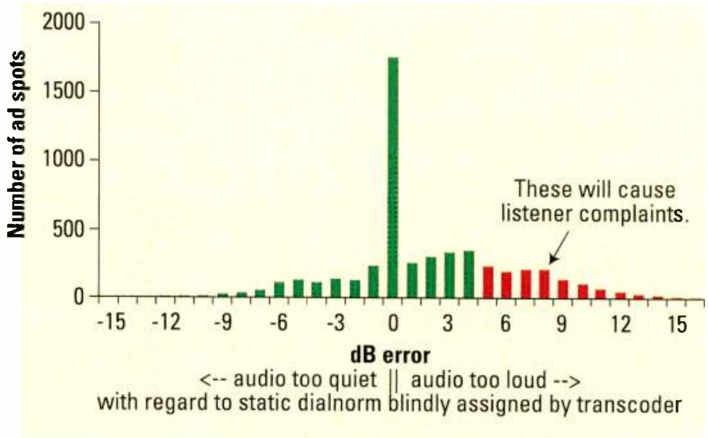

Figure 1. File-based transcoding with static dialnorm for Group I

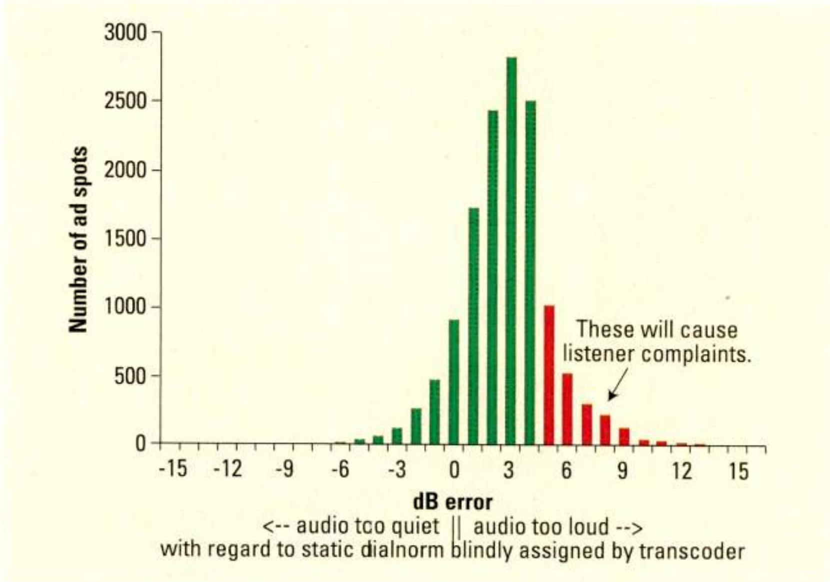

Figure 2. File-based transcoding with static dialnorm for Group II

have improved consistency and predictability for its viewers, the ultimate goal. In addition, the process is scalable, and therefore relevant to all distribution stages, from program creation to networks and local stations. Overall, the results of this study provide a practical blueprint applicable to any broadcaster wishing for consistent, repeatable and predictable results in quality control procedures and the proper setting of dialogue normalization parameters.

Due to the lack of dialog normalization metadata, Time Warner Cable's ad spots had previously been transcoded in a blind fashion, using a commercially available transcoder with a default set of Dolby Digital metadata settings, but quality controlled using a LM100 and then processed appropriately matching dialogue normalization with content loudness. Specifically, all were transcoded to a static dialnorm value prior to final QA.

Steps to improve subscriber experience

The blind file-based transcoding with a static (default) dialog normalization value leads to unnecessary level shifts away from the Dolby Digital decoder reference level (in the set-top box or A/V receiver). The master control center used a Dolby DP600 program optimizer to analyze and subsequently nondestructively correct the success rate of blind transcoding, using the system's adaptive and automated speech-based ITU-R BS.1770 measurement method.

The analyzed (and subsequently corrected) ad spots were divided into two groups for analysis. Group I contained locally produced content, primarily ingested via FTP directly from ad agencies. Group II comprised ad spots delivered via a popular ad content aggregator.

For Group I, only 34 percent of material had correct dialog normalization (after the blind transcode). (See Figure 1.) Group II did not fare nearly as well, with only 6.7 percent success. (See Figure 2.)

In both groups, the incorrectly set values were dispersed over a fairly wide dynamic range. Group II fared even worse in this regard. While the majority of content was spread over a smaller loudness range, that distribution of individual loudness values was centered at approximately 3dB above the correct dialog normalization value.

Subsequently, the automated analysis and correction engine on the DP600 was used to correct the dialog normalization value within each of the ad spots. This process does not require a decode/re-encode cycle. It recomputes dynamic range control metadata parameters (i.e., it does not impact program dynamics), in addition to correcting the dialog normalization value, in faster than real time.

The difference between blind-transcoded files and files corrected using the DP600 was dramatic. For corrected files, the level was much more in balance with the surrounding program content. A comparison of corrected and uncorrectd ad spot audio levels as they relate to the surrounding program audio levels can be seen in Figures 3 and 4.

Lastly, the study also required ensuring that the dialog normalization value on every digital simulcast encoder was correctly provisioned. The correct dialog normalization value for each digital simulcast service was derived via long-term dialog measurements using a Dolby LM100 broadcast loudness meter.

Checklist for success

Overall, the results of this study provide a practical blueprint applicable to many broadcasters wishing for consistent, repeatable and pre-

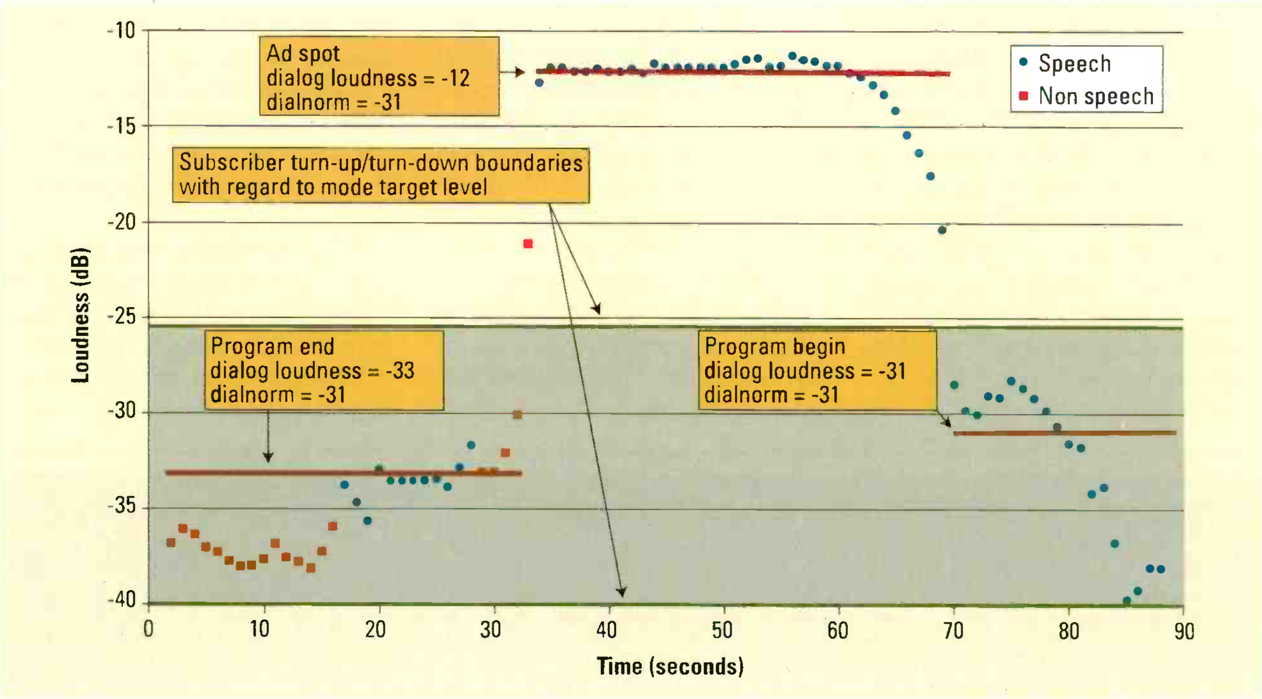

Figure 3. Diagram showing a program-to-ad spot to program transition, with ad spot dialnorm incorrectly set at -31dB

dictable results during the quality control process as well as ensuring the proper setting of dialog normalization parameter for every piece of content.

There is an increasing amount of documentation supporting proper use of Dolby Digital metadata and dialog normalization as a means to improve subscriber satisfaction. Loudness issues that have hampered the consistency of cable broadcast audio can be easily addressed if the industry moves forward together with the proper use of dialog normalization (or by a local decode/re-encode stage at the headend). If content providers, post-production houses and manufacturers throughout the industry continue to work with networks and programmers, together we can ensure proper provisioning of dialog normalization, consistent levels for all programming, reduced complaints and better viewing for all. BE

Ivan Larsen is regional technical services manager with Time Warner, and Jeffrey Riedmiller is technology architect, broadcast, for Dolby Laboratories.

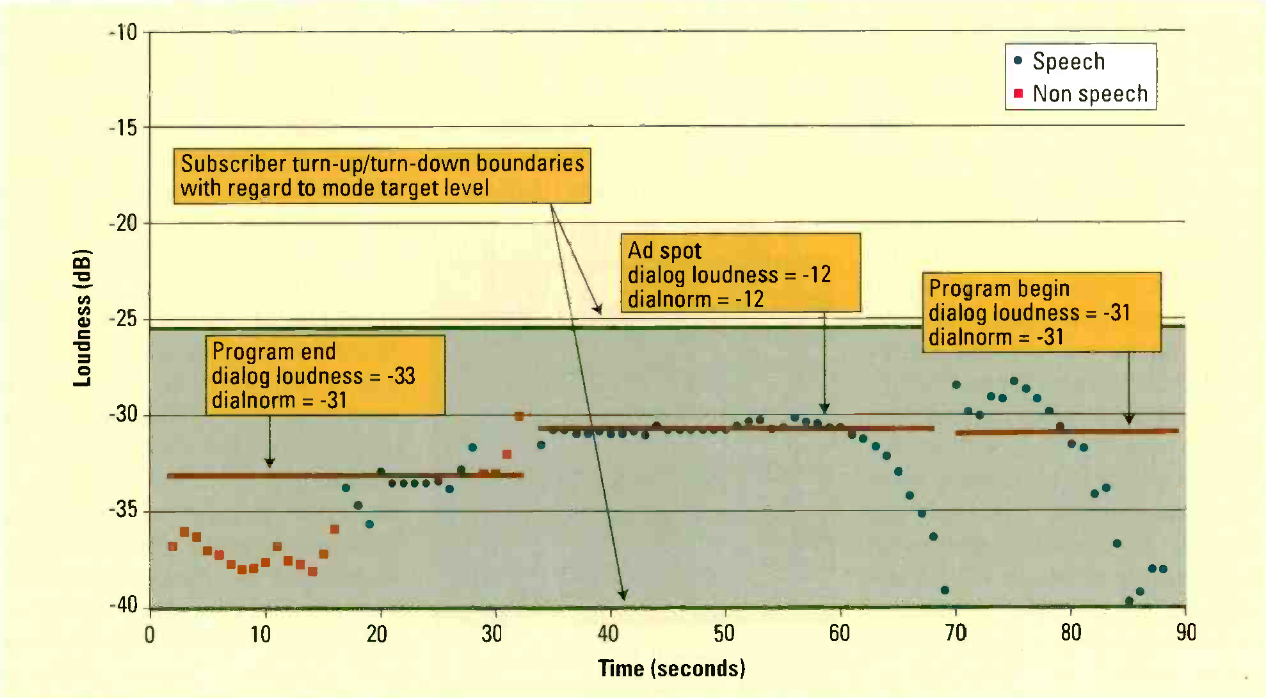

Figure 4. Diagram showing a program-to-ad spot to program transition, with ad spot dialnorm correctly set at -12dB

Video encoders

Effective compression limits the introduction of artifacts.

BY JOHN LUFF

There are few places in modern video technology where technical complexity is higher than in video encoders. First, the purpose is to wring out of a running video as much of the data as possible without destroying the watchability of the content. Second, this needs to be done in a way that produces an output stream that conforms to tight specifications. The reason is related to a fundamental decision made at the time the standards are written. MPEG-2 encoders are intended to put the complexity and cost burden on the encoder, making the decoders cheap to build and deploy.

I would like to point out that there are two types of encoders: those that preserve quality by eliminating losses of content as much as possible and those that maximize the compression at the expense of quality, though in a controlled manner. The psychophysics of the process is reasonably well-known. For example, detail is less visible in motion and in deeply saturated colors. So an encoder can throw away content in areas of high motion, where redundancy between frames is great, to maximize the compression ratio.

Many tools abound for doing this in the MPEG toolkit, including run length encoding, entropy coding, motion vectors and block matching, predictive frames, and the basic tool used to convert spatial data into the frequency domain, using discrete cosine transform (DCT). (See Figure 1.) By creating blocks that code spatial frequency in the vertical and horizontal direction and then applying quantization to the resulting matrices, it is possible to quantize the high frequencies to a low level, leaving the visible low-frequency data to be coded with the highest precision possible. This preserves the quality that people actually perceive as most important. You might say the trick is to figure out what will not be missed, and then to design the math to do the transform with a minimum of calculation.

Video encoding is complex

In the end, despite years of development, the engineering and science of video encoding remains complex, perhaps increasingly so. It is arguable that in highly refined products, the complexity is highest.

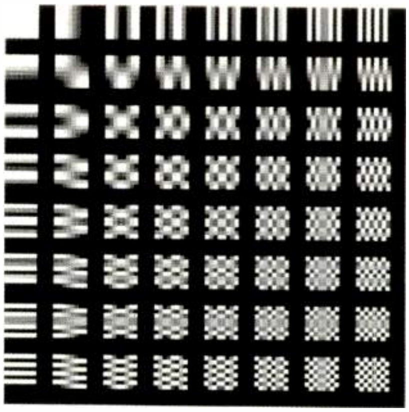

Figure 1. Every 8 x 8 image block is coded as a weighted combination of these 64 DCT basis functions.

For example, when an encoder processes video, it first looks at the content and guesses how it should encode specific areas of the picture to achieve the best result. By looking at the results and the residual errors in the content, it is possible to do a second pass at encoding using data gathered by the first pass to make the second one more effective at reducing the data rate while maximizing picture quality. In doing so, a varible bit rate encoder can hold available bits from easy pictures and apply the resources to complex, hard-to-encode pictures. This two-pass encoding requires memory and processing horsepower, which costs real dollars in any platform, software or hardware.

It is also often assumed that with modern computers, software can be as fast as special-purpose hardware at completing complex tasks given the speed of modern processors and techniques. As a general rule, that is possible, but in the case of video encoding, the sophistication of the processing and the amount of data that must be processed in real time makes most general-purpose computing platforms too slow for these tasks. This is especially true for real-time encoding of low bit rate HD content, particularly H.264.

Reducing a 1080i30 HD signal (1.24Gb/s of picture content) to 19.39Mb/s requires that 98.44 percent of the content has to be thrown away in real time, without making the picture so bad that no one will watch it. To drop it to 12Mb/s, as is done in many cases today, means a staggering 99.04 percent of the picture has to be dropped on the cutting room floor. That amounts to a slim 0.19 bits for every pixel (Y, R-Y, B-Y taken as one pixel). Or perhaps it makes sense to say five pixels are represented by one bit.

Advanced coding is in demand

This level of complexity, along with the simple fact that bits represent bandwidth, which equates to dollars, means that encoders capable of high-level compression without visible artifacts are highly desirable and valuable. The inevitable desire to cut bandwidth leads to research into advanced coding. This is why H.264 has started replacing MPEG-2 for many applications. The tools available in the more recent H.264 specification allow higher levels of compression without introducing obnoxious artifacts.

There is a downside, of course. An H.264 encoder that uses the full toolkit is much more complex. And though it can produce pictures with either improved picture quality or reduced

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It seems reasonable to assume that future implementations will embrace an ever wider array of compression tools.

bit rates, it costs more. Over time, the cost of encoders is coming down as the hardware that implements them becomes more ubiquitous. Like all things, volume begats price reductions. However, there is a limit. Volume production in the consumer marketplace is numbered in the millions, tens of millions or hundreds of millions. In our small industry, that number is more likely in the thousands or tens of thousands. This means R&D costs have to be spread across a smaller universe of products, with perhaps a longer lifetime.

There are special cases where this volume production problem has a major effect on compression product development. The H.264 standard includes 4:2:2 and 4:2:0 coding modes. The latter provides higher compression ratios and thus is applicable to the consumer. Coding at 4:2:2 is ideal for backhaul of content intended for later processing, but unfortunately that capability is only needed for low-volume products intended for a niche market. Over time, the ability to code 4:2:2 streams will be included in newer silicon integrated circuit solutions, making high-quality MPEG-4 applications cheaper to implement. In the meantime, other applications might be stuck with MPEG-2, where 4:2:2 is required and 4:2:0 is just out of the question since MPEG-2 4:2:2 is readily available today.

Compression technology, which has spawned an amazing array of applications not possible before, has continued to march. JPEG, originally developed for still images and adapted as motion JPEG to video, begat MPEG-2 with more complexity and a richer feature set nearly 20 years ago. Now a newer JPEG effort, JPEG2000, has been popularized for digital cinema and other applications where the highest quality, approaching mathematically lossless performance, is appropriate. Other coding schema will be developed for other purposes. We already see consumer decode chipsets that do MPEG-2 and MPEG-4 (H.264) for both broadcast and DVD applications. It seems reasonable to assume that future implementations will embrace an ever wider array of compression tools. **BE**

John Luff is a broadcast technology consultant.

Send questions and comments to: john.luff@penton.com

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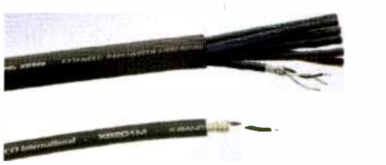

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Dual audio distribution amplifier consists of two separate distribution amplifiers in a single case — a 1 x 4 analog stereo distribution amplifier via 3.5mm ministereo connectors and a 1 x 4 S/PDIF distribution amplifier via RCA coaxial connectors; inputs between the two amplifiers don't cross over, and there is no analog-digital conversion between the two; features an audio bandwidth of 20Hz to 20kHz; signal processing system ensures a low signal-to-noise ratio plus flat equalization curves throughout the bandpass spectrum.

800-721-4044; *www.tvone.com*

Niagara Pro II — ViewCast

Encoding appliance captures, encodes, streams and compresses files for professional-grade digital video and audio delivery; supports SD-SDI video and AES/EBU digital audio capabilities; streams multiple resolutions at multiple bit rates in multiple streaming formats, including MPEG-4, Adobe Flash Live, Windows Media (Silverlight-compatible) and RealVideo; individually customizes streams with bitmap overlays; includes front-panel LCD status display, control buttons and multisegment LED audio meters.

800-540-4119; *www.viewcast.com*

OTP-1HDP — Emcore

Optiva module transmits two independent 3G video signals; able to transmit up to 30 424M-compliant video signals through a single 3RU 19in chassis; supports full 1080p, 50/60Hz SMPTE 424M-compliant video, as well as SMPTE 292M, 259M, HD-SDI and SDI video broadcast formats; fits easily into Optiva 1RU and 3RU rack-mount enclosures or stand-alone desktop enclosures.

505-332-5000; *www.emcore.com*

Stasis Flex — Anton/Bauer

Camera support system redistributes weight of a handheld camera onto the operator's torso and over the shoulder; features adjustable mechanism that provides the operator with complete flexibility in forward/back, in/out and up/down positions; can be used as a stand-alone unit; accommodates various peripherals, including wireless receivers, hard drives and transmitters.

203-929-1100; *www.antonbauer.com*

ProQ — Nucomm

DTV IFB receiver features dual UHF/VHF antennas, two advanced silicon tuners and sixth-generation VSB demodulators; contains an MPEG Layer 1/Layer 2 audio decoder that can decode two independent sound programs, providing up to four audio channels and using bit rates as low as 32kb/s for each; can map the IFB audio channels to the XLR outputs, internal speaker or headphones; displays real-time status information on a front-panel LCD display.

908-852-3700; *www.nucomm.com*

NB-9 nanoBox — Eyeheight

Free-standing desktop chassis accommodates any of the company's range of single-height cards, including legalizers, safe-area generators and SDI-embedded audio shufflers; operates from a 7.5V DC supply and comes with an external power brick working from universal AC mains; includes British, European and North American plug fittings; can be controlled from company's FP-9 remote panel via RJ45 connection.

623-328-5800; *www.eyeheight.com*

Flow — EditShare

Shared storage system comprises ingest and browse applications; ingest acquisition solution captures in one format and simultaneously outputs to multiple formats including Apple ProRes 422, Avid DNxHD and low-res proxy formats; features multichannel ingest with independent control over each channel, full metadata capture and the ability to edit while recording; browse enables users to quickly locate media; supports proxy viewing outside the nonlinear editing application for optimal viewing in the EditShare space, annotation of metadata forms and the ability to drag and drop media into an Avid or Final Cut Pro bin.

617-782-0479; *www.editshare.com*

EX 0.75 — 16x9

Aspheric wide converter provides 25 percent greater angle view while maintaining full zoom capability; reduces geometric distortion and chromatic aberrations; improves off-axis wide-angle performance; contains four multicoated optical glass elements; attaches securely to the front of the Sony PMW-EX1 and EX3 via bayonet mount.

661-295-3313; *www.16x9inc.com*

RFX-PHT-II — RF Central

HD-upgradable, portable 2GHz digital transmitter comes with 5W power output standard (7W upon request); supports 480i, 720p 1080i formats, as well as analog, digital AES and fully embedded audio; accepts either composite or component analog video or HD-SDI digital signals; has an ASI input; offers multiple modes of COFDM modulation, including QPSK, 16QAM and 64QAM.

717-249-4900; *www.rfcentral.com*

SpeakerLUX — Wireworks

Flexible loudspeaker cable with 49-strand 13-gauge bare copper is available in two, four, six and eight conductors; features a flexible PV black satin finish, pressure-extruded jacket and color-coded insulation; produces lay-flat cable; eliminates the need for plastic or string fillers.

800-642-9473; *www.wireworks.com*

Vérité Series — JVC

HD LCD monitors in 17in, 20in and 24in versions use JVC's third-generation imaging technology to minimize delay between input signal and image display; feature 10-bit 4:4:4 video processing, advanced edge artifact elimination, deinterlacing and computer-automated calibration of black level, white level, color temperature and gamma; include a built-in waveform monitor with over-level indication and ultra-low latency circuitry for lip-sync accuracy.

973-317-5000; *http://pro.jvc.com*

NV9000 — NVISION

Router control system can control 250 routers, 400 control panels, and up to 250 physical and 512 virtual levels; includes purpose-built system controller hardware foundation; features include redundant power supplies, solid-state hard drive, six network control points and the NV9000-SE configuration utility.

530-265-1000; *www.nvision.tv*

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convertCON — Neutrik

Three-pin cable connector can be transformed from a male to female connector by sliding the housing back and forth, allowing for the use of one connector because it can mate with either a male or female three-pin XLR connector; shares features and benefits of XLR XX series; features an improved chuck-type strain relief that provides higher pull-out force and makes assembly easier and faster.

732-901-9488; *www.neutrik.com*

Acrobat — Riedel Communications

Digital wireless intercom system includes one or more Cell Controllers with up to 80 Cell Antennas, wireless belt packs and VoIP-over-DECT platform; enhanced channel agility allows system to use complete DECT frequency and channel spectrum by allocating calls to any free RX or TX timeslot; Cell Controller handles VoIP-over-DECT cell management and connects to any party line or matrix intercom via eight analog four-wire ports and 12 GPIOs; Cell Antennas connect via Ethernet and have a range of 275m under line-of-sight conditions or 75m indoors.

818-241-4696; *www.riedel.net*

PRC-EX1 — Petrol

One-piece rain cover for Sony PMW-EX1 and HVR-Z7 cameras is constructed of clear polyurethane for quick, easy access to all camera features; enables work with the flip-out LCD screen fully open; hot shoe connector in the cover's rigid front hood section anchors and stabilizes it on the camera; durable, waterproof rubber fabric surrounds and protects the viewfinder.

845-268-0100; *www.petrolbags.com*

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COMING IN NOV.

Video compression & artifacts

Presented by Aldo Cugnini

Nov. 11, 2008 – 2:00 pm EST

As viewers replace their analogTV sets, they will increasingly be aware of any compression or conversion artifacts that stations broadcast. This engineer-level class will help you better understand how compression works and the effects it can have on image quality. You'll learn how preprocessing and signal conditioning can reduce compression artifacts and improve your signal quality.

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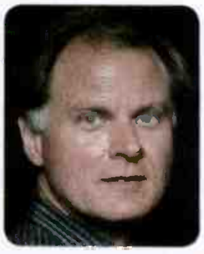

Understanding TV audio systems

Presented by Jim Starzynski

Dec. 9, 2008 – 2:00 pm EST

Audio used to be an afterthought for television engineers. Not today—as viewers equip their homes with wall-sized audio systems. Jim Starzynski will lead a discussion about TV audio systems. Attendees will learn how surround sound, Dolby E and multiplexed audio can improve their station's image with viewers.

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ROSCOR Corporation, a leading Chicago area based video systems integration company, has openings for experienced, highly motivated, and goal-oriented communications systems engineers. The position includes system design, checkout and commissioning of media based integrated solutions, including broadcast and corporate communication customers. Solid background in television systems, transmissions systems and satellite communications system design. Excellent compensation and benefits package. Apply immediately for this challenging and exciting career opportunity within a growing company.

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KGAN/KFXA, Cedar Rapids, IA FOX and CBS affiliates are seeking an Assistant Chief Engineer. The successful applicant will have an in depth knowledge of digital and analog technologies as used in a broadcast environment, as well as a complete understanding of IT networks, high power UHF Transmitters, broadcast equipment and microwave RF technology. For more information and to apply online go to **www.sbgi.net** and follow the employment links. EEO/Drug Free

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WANE-TV is seeking a Chief Engineer to assume the responsibility for the technical facilities in Fort Wayne, IN. Position involves technical planning, project management, staff development, and administrative functions. This is a department-head level position that requires close interaction with other departments and the ability to effectively present information and respond to questions from managers, clients, customers, and general public. Candidate must be able to prepare and administer capital and operating budgets for technical facilities and ensure station compliance with all FCC and OSHA regulations. The ideal candidate will have an extensive knowledge of TV broadcast station systems and integration in a progressive media environment. Broad RF experience is necessary in areas including broadcast, microwave, and satellite communications. Practical knowledge of electrical, plumbing, HVAC and basic construction techniques are important. Candidate must be able to design, install, and document new systems as we progress through high definition production and pursue new media avenues through digital distribution. Technical degree in Electrical Engineering or related field or equivalent level of experience. SBE Certification is preferred. Candidate must have 5+ years experience maintaining modern broadcast equipment. No phone calls please. Send resume to: Alan Riebe, Station Manager, WANE-TV, 2915 W. State Blvd., Ft. Wayne, IN 46808. WANE-TV is an Equal Opportunity Employer-M/F

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What's in your TS?

You cannot afford to be stumped by this question.

BY ANTHONY R. GARGANO

For years, the mainstay tools of television engineers in stations and facilities all around the country have been the trusty waveform monitor and vectorscope. Throughout studios, edit rooms, engineering facilities and broadcast centers, TV stations large and small, as well as broadcast and cable networks, are replete with these workhorse test and monitoring instruments. And, for simple go/no-go testing, there is the ubiquitous video monitor. Tap virtually anywhere into that NTSC video signal path and either video or a blank screen appears, quickly telling you whether there is a signal or not and what the content of that signal looks like visually.

In the early days of television, Tektronix — then a nascent manufacturer of oscilloscopes for general test and measuring applications — introduced a version of one of its scopes, the 524AD. According to the operating manual, it was "specifically designed for maintenance and adjustment of television transmitters and studio equipment." This was one of the first such instruments dedicated to television signal measurement and analysis using visual display parameters. Next were dedicated full-rack-width waveform monitors and vectorscopes, followed by the half-rack displays that have been so prevalent over the past several decades and ultimately evolving into today's multifunction single unit displays.

In analog television, broadcasters have long been concerned about sync and burst measurements, white level and black level settings, differential phase and gain . . . the list could go on and on. As analog goes dark, we face a new glossary of terms and a new set of monitoring and measurement concerns. The relatively easy to view and measure analog signal is now being replaced by an SDI signal that is being compressed and encapsulated into a transport stream (TS). That TS carries multiplexed, packetized data representing one or more programs and services and is then 8-VSB modulated to carry it to off-air DTV receivers.

Test and measurement equipment has evolved from its early days. Shown here from top to bottom are Tektronix's 524AD oscilloscope for general test and measurement, Tektronix's 526 vectorscope, Harris' Videotek TVM-950 multifunction display, and Rohde & Schwarz's DVM 100 real-time MPEG-2 monitoring system.

Enter the new lexicon. With a new set of critical concerns — bit error rate (BER), modulation error ratio (MER), program clock reference (PCR) drift and jitter, and Program and System Information Protocol (PSIP) table errors — waveform monitor and vectorscopes designed during the 8-track era cannot quite cut it in a digital world.

But, your friendly purveyor of test instruments can come to the rescue. Welcome to the world of MPEG monitors and analyzers. In the digital world, test and measuring is important. Forget the graceful degradation of analog signals slowly sinking into noise and distortion, and welcome to the cliff effect. In our digital world, the video is either there or not there. If it is there, it is either pristine or pixelized. Have excessive PCR jitter? Get ready for the "why is my screen blank?" phone calls. There are a myriad of problems that can cause that viewer screen to go blank. Need a refresher on MPEG measurements? You can find helpful articles on the *Broadcast Engineering* Web site. And, don't overlook that heretofore mentioned friendly test equipment purveyor. I'm sure he would be happy to provide an MPEG test and measurement primer during the course of demonstrating that box he wants to sell to you.

Remember that infamous technician who thought he was having a private viewing of a porn film? That TS is capable of carrying multiple services; better know what's in it. It's almost February. What's in your transport stream? BE

Anthony R. Gargano is a consultant and former industry executive.

Send questions and comments to:
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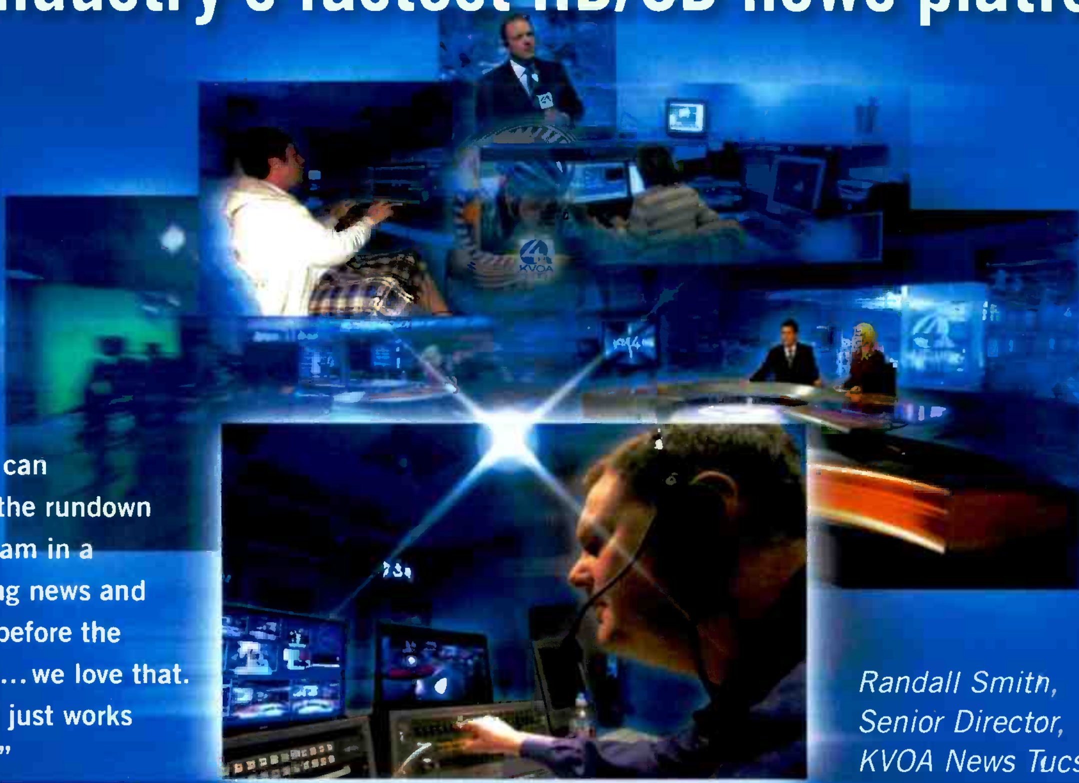

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