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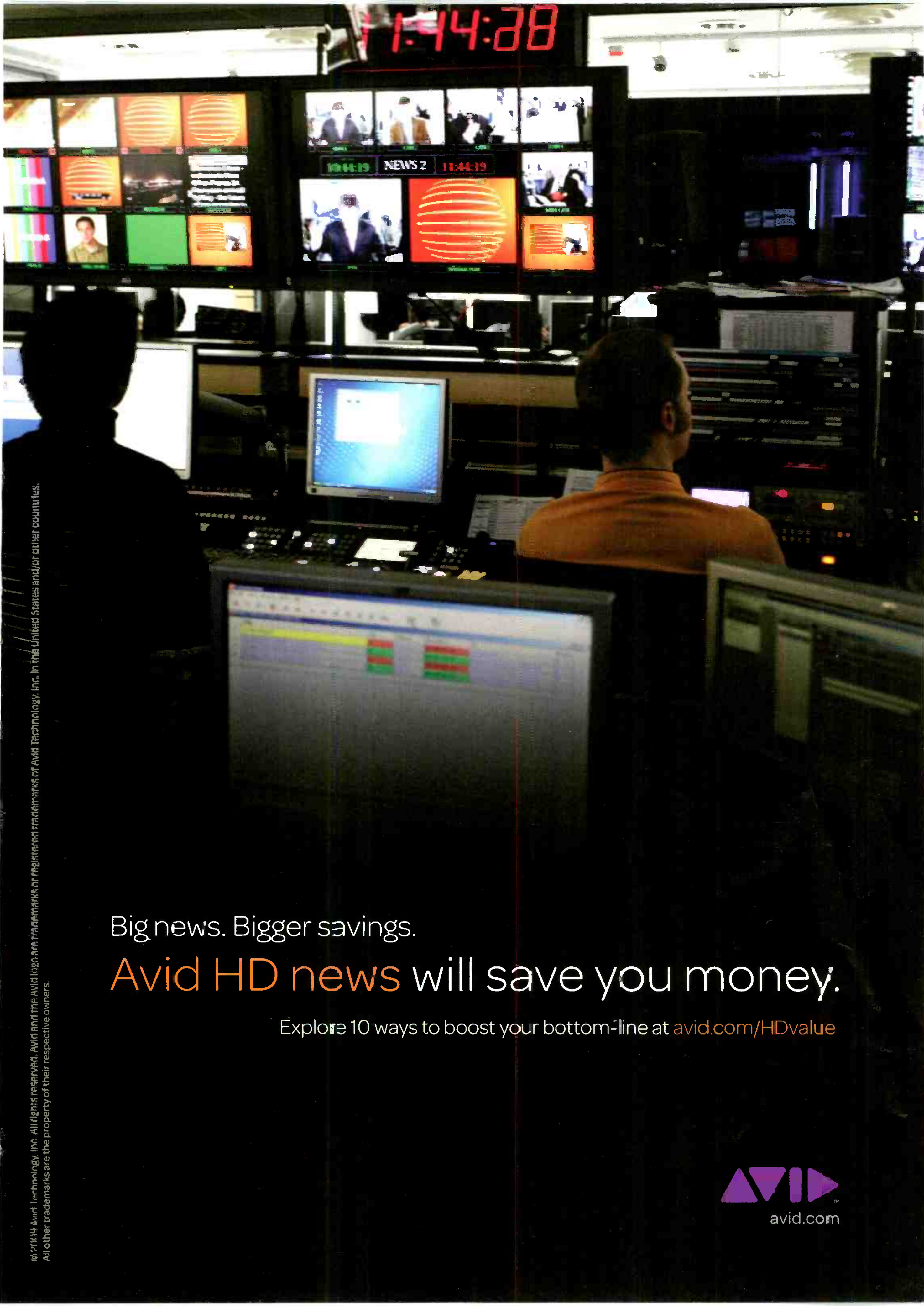

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TABLE OF CONTENTS

VOLUME 51 | NUMBER 8 | AUGUST 2009

BroadcastEngineering®

FEATURES

BEYOND THE HEADLINES

DOWNLOAD

FCC UPDATE

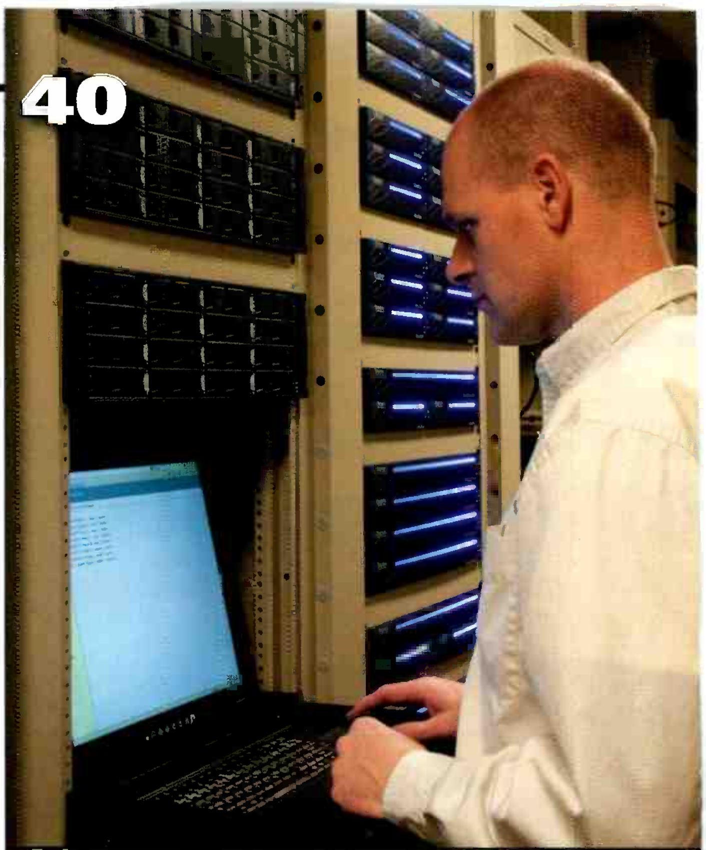
DIGITAL HANDBOOK

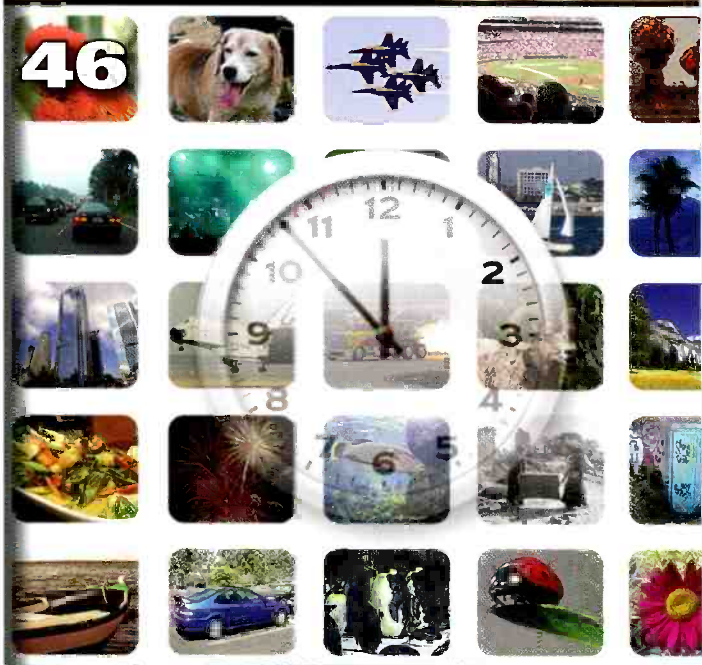
TRANSITION TO DIGITAL

COMPUTERS & NETWORKS

PRODUCTION CLIPS

continued on page 6





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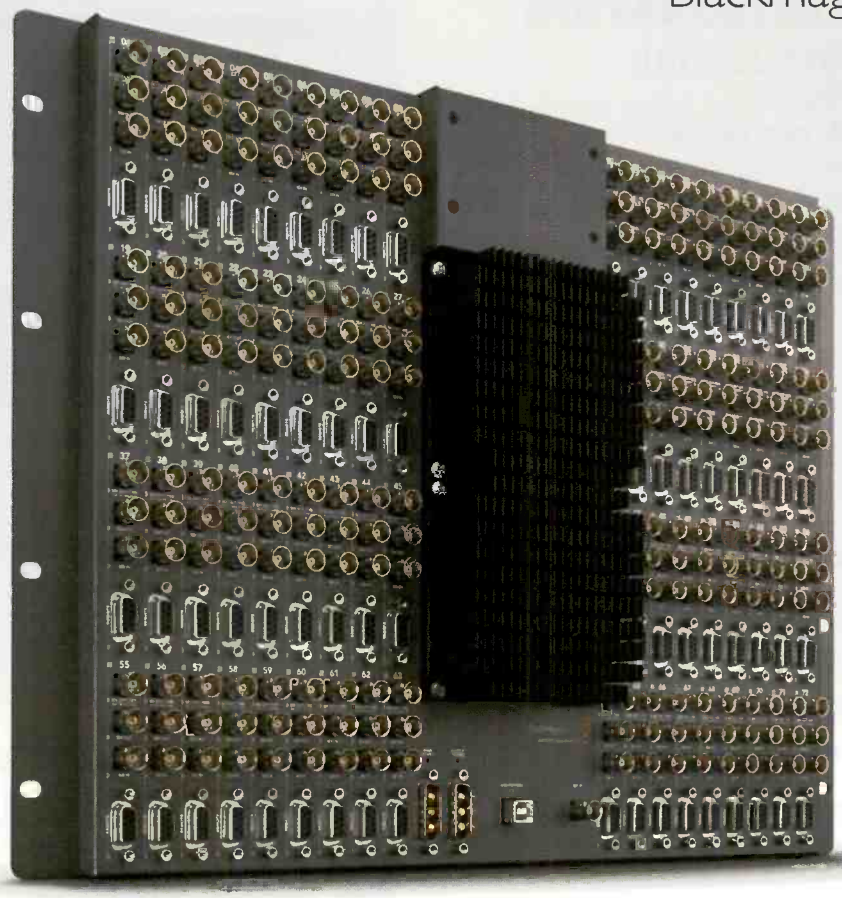

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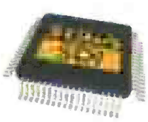

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TABLE OF CONTENTS (CONTINUED)

VOLUME 51 | NUMBER 8 | AUGUST 2009

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LATEST NEWS!

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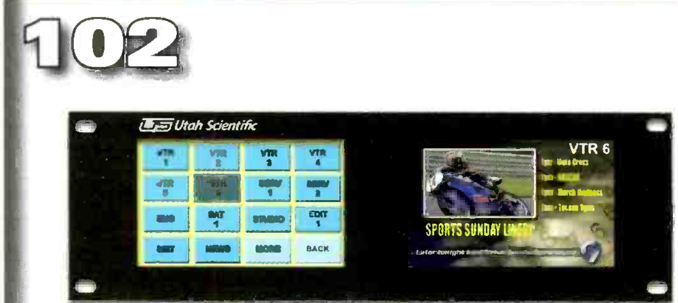
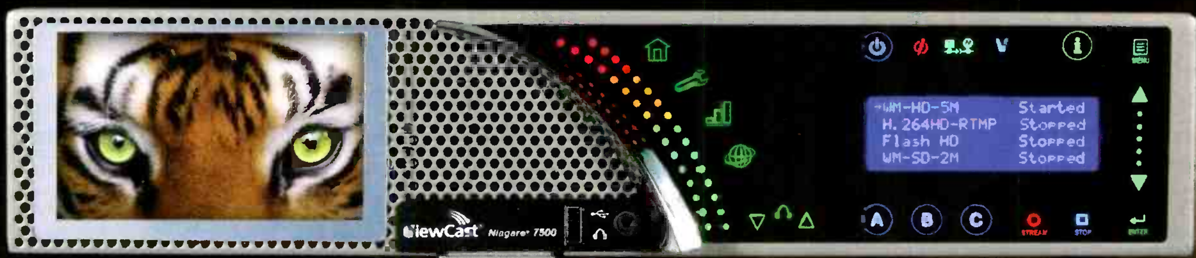


Beauty on the outside.
Beast on the inside.



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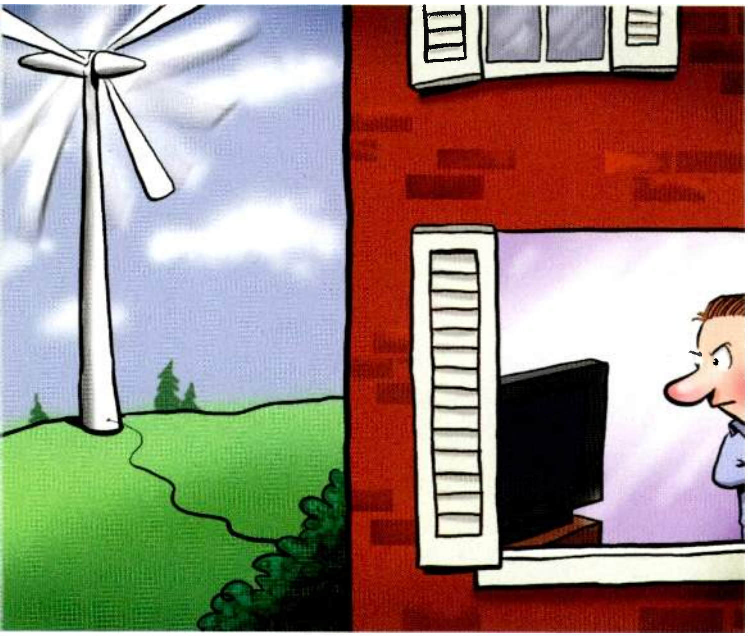
Is it a toy or a tool?

I recently stumbled across the TV program "Living with Ed." The show stars Ed Begley Jr. and his wife, Rachelle Carson. Begley is probably best known for his former role as Dr. Victor Ehrlich on the series "St. Elsewhere." The "Ed" program began on the HGTV channel, but has since moved to the Planet Green channel.

If you've never seen the show, let me describe Ed for you: He's a nutcase — a loveable nutcase, but still a nutcase. His singular purpose in life seems to be finding ways to be even more energy efficient and environmentally friendly. For instance, Ed rides a stationary bicycle connected to a generator, which allows him to produce electricity so he can toast his bread for breakfast. Each new show highlights his latest project to help him get closer to living "off the grid."



There's a third person on the show, Ed's next door neighbor Bill. In reality, he is "Bill Nye the Science Guy." Bill's environmental fanaticism almost makes Ed look normal. The two are engaged in a running battle to see who's the most environmentally efficient.

When Ed installed a solar collector, Bill installed a larger solar collector. Despite Rachelle's pushback, Ed installed ugly brown plastic rain barrels. Bill then bested him by installing decorative and sophisticated-looking rain barrels.

As an aside, I saw a large plastic rain barrel in my local grocery story this week. It looked just like a huge can of Campbell's Tomato Soup. Please tell me these aren't available for sale. I'm afraid my neighbor's house could soon resemble an industrial storage pantry with 4ft soup cans located under each downspout.

Back to "Ed." The show highlights the ongoing technology battle between these two eco-nuts. On one particular show, Bill grinned from ear-to-ear as he escorted Ed and Rachelle through his home, pointing out the technology he has installed to become more environmentally efficient.

The first stop was the house's electricity meter. Bill was glowing with pride as he showed Ed that his meter was going backward, meaning he was selling power back to the power company. Ed's frown was a hint that he felt the need to soon address his own power technology deficiency.

The second stop on the tour was the solar water temperature controller in the bathroom. Rachelle suggested the controller looked geeky and should have been mounted out of sight inside a towel cabinet. Ed thought it was cool.

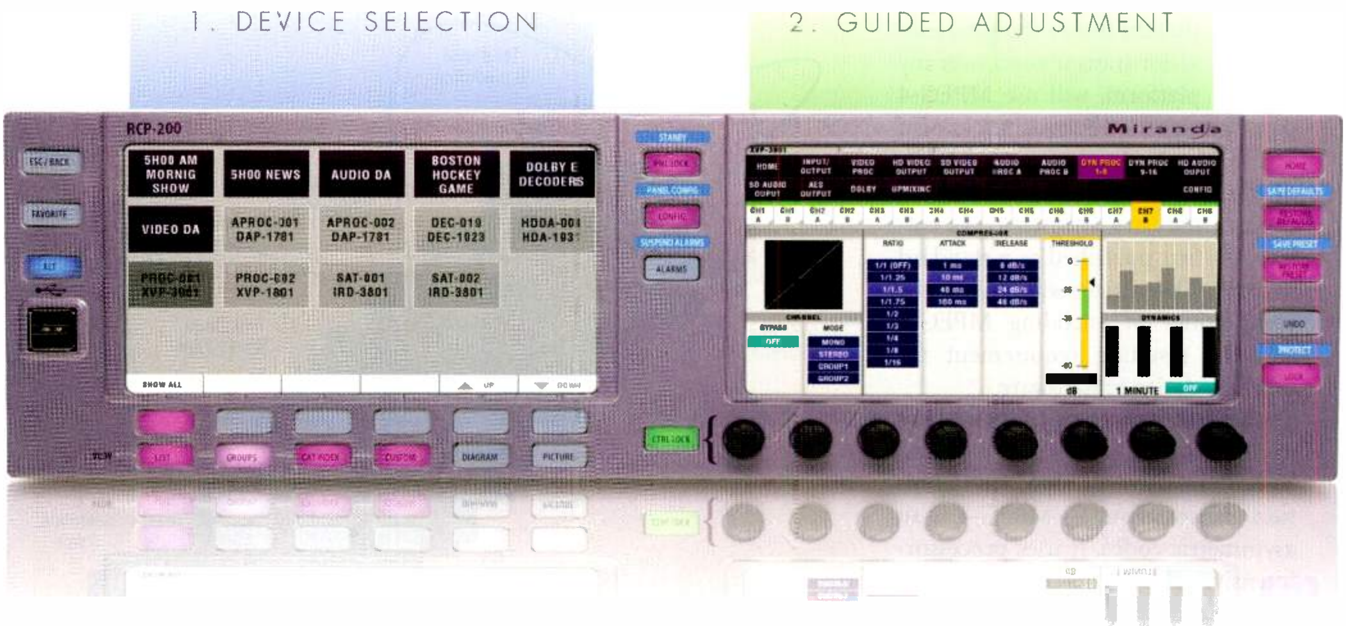
Each show culminates with Ed installing some new piece of eco-technology. This show focused on the installation of a wind turbine generator. It was Ed's response to Bill's negative power bill.

The first step was for Ed to saw off a 3ft section of his roof overhang so the turbine's mounting pole could be bolted against the side of his house. Then we see Ed and the turbine company installing the turbine's rotor above the garage. (Don't these housing developments have homeowners' associations?)

By the end of the show, viewers see Ed glowing proudly as he shows Rachelle the turbine slowly spinning in the Hollywood wind, producing electricity — a whole 500W. Rachelle stares into the camera with a "So what?" look. I agree with her — $3500 for a 500W generator? What's the sense in that?

The point of all this is that we engineers can get caught up in chasing our own technology tails. Gadgets, both personal and professional, can be fun, but the more important consideration is whether the technology helps us be more efficient and effective in our lives. If it doesn't, then it is little more than a toy. **BE**

Brad Dick
EDITORIAL DIRECTOR
Send comments to: editor@broadcastengineering.com



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Delivering MPEG-4

A dedicated DSP chip means more onboard processing in a familiar environment.

ARE OLAFSEN

There is general agreement that the future of digital television transmission, over any platform, will use MPEG-4 part 10 as a codec. Sometimes known as the advanced video codec (AVC), or the ITU-T standard H.264 to the telecom industry, MPEG-4 was collectively first published as a standard in 2003. This article will look at the complexities of encoding MPEG-4 and the resulting requirement for carefully designed hardware.

The first important point to bear in mind is that, like MPEG-2 — still commonly used for standard definition transmissions — MPEG-4 is an asymmetric codec. It uses processor-intensive algorithms to create the compressed stream but is relatively simple to decode, allowing it to be implemented in an inexpensive chip embedded in millions of set-top boxes and television receivers.

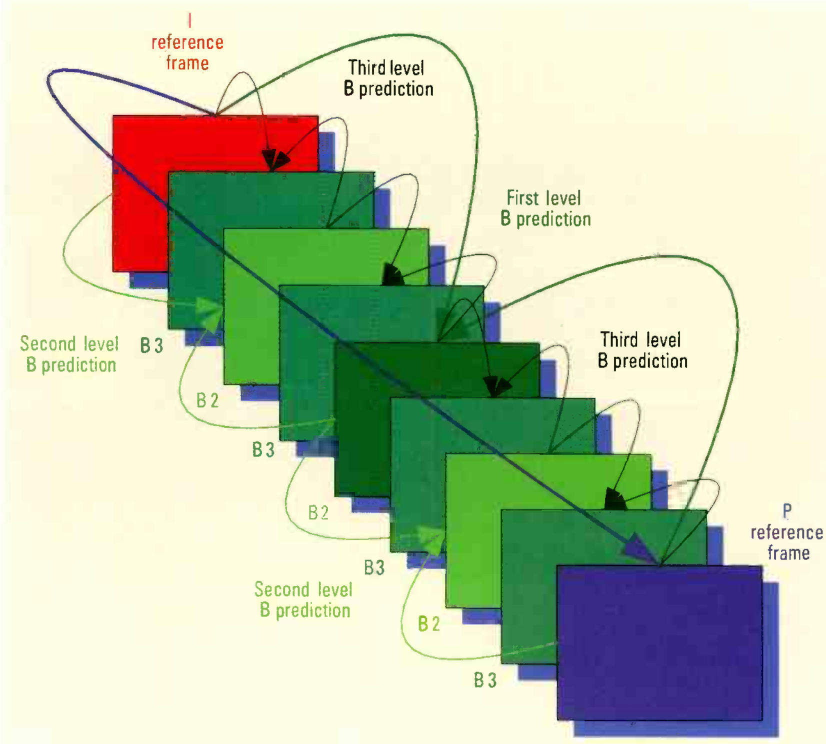


Figure 1. H.264 uses multiple reference frames.

One fundamental economic consideration: Consumer goods manufacturers would be extremely reluctant to tolerate any increase in their manufacturing costs, so when moving from MPEG-2 to MPEG-4, the decoding process has to be broadly comparable.

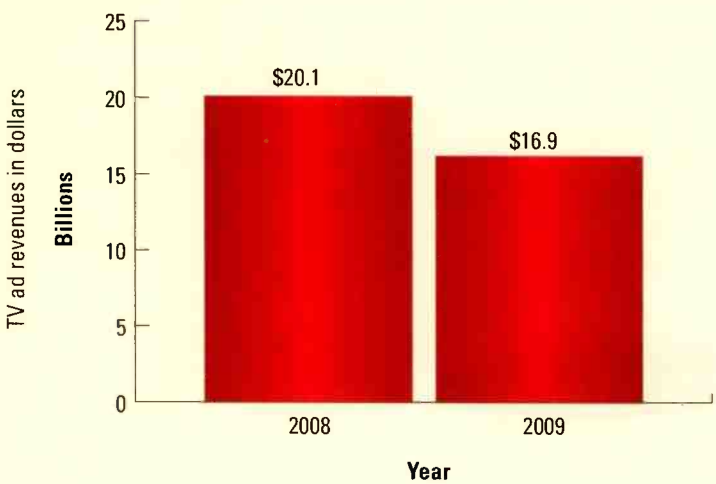
The team working on the AVC project was tasked with the goal of achieving comparable video quality at half the bit rate (or lower) than MPEG-2. Given that there was no option to increase the decoder significantly, it put even greater pressure on the encoding algorithms.

The solution was to build on the fundamental building blocks of MPEG-2 — discrete cosine transforms within macroblocks on individual frames and the use of reference frames

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

Broadcast TV ad revenues declining

Ad spot revenue is estimated to drop 15.7 percent from last year.



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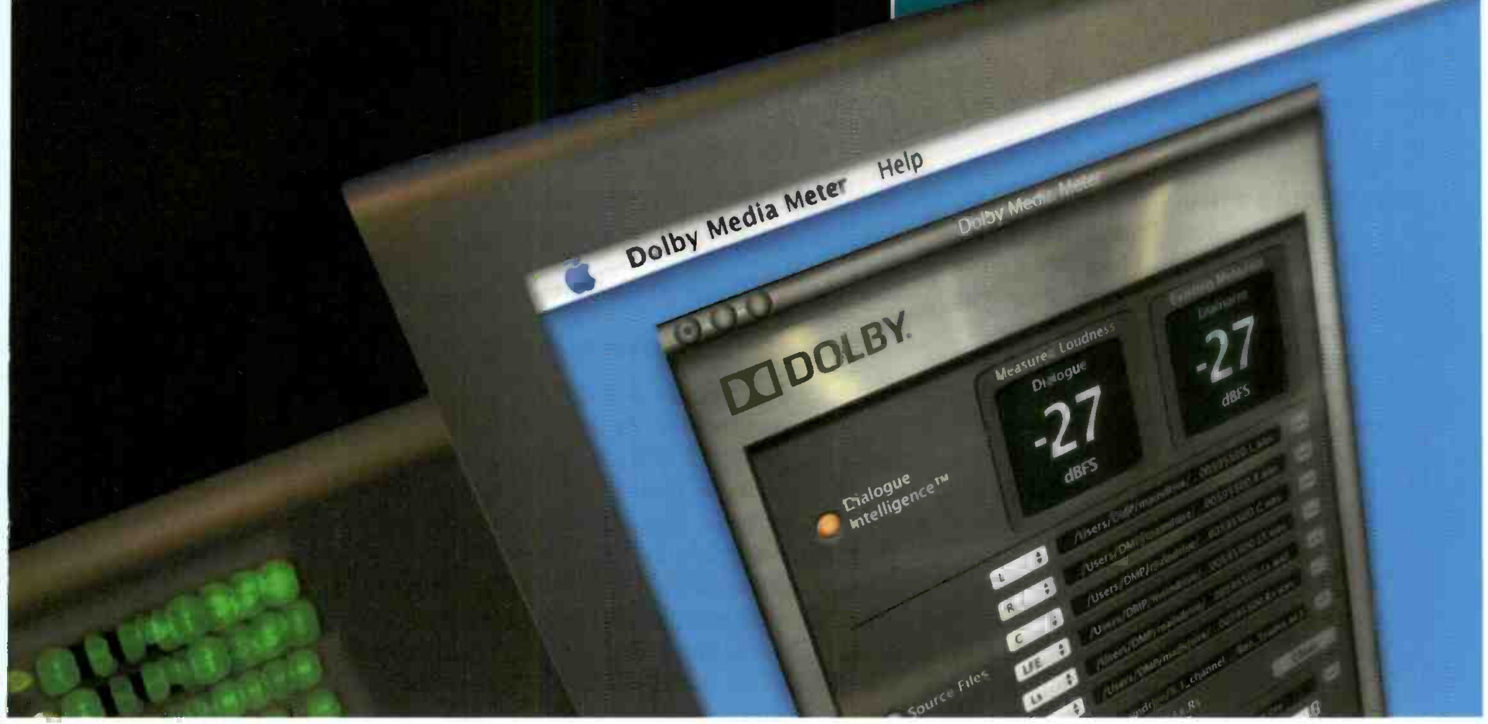

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for additional temporal compression — but add considerably more depth of processing in each area. This took advantage of the vast increases in processing power available since the original MPEG-2 standard was established a decade or more earlier. But it remained highly challenging, which is why many of the elements are regarded as options and few, if any, commercial encoders attempt to use the full toolkit.

Coding efficiency

There is not enough space here to list all the additional techniques AVC uses to improve coding efficiency, and many require a detailed understanding of the mathematics behind the theories in order to appreciate them. However, it is worth looking at some of them in outline view.

Perhaps the most important step change is the move to multiple reference pictures. (See Figure 1 on page 10.) Whereas MPEG-2 uses one or at most two reference pictures in interframe coding, AVC permits the use of up to 16 frames (32 fields in interlaced television). In some cases — rapid back-and-forth cuts between two camera angles, or scenes with a relatively large expanse of background (a golf course, for example) — this can produce dramatic savings in the bit rate.

Motion vectors also play a big part in providing a good prediction of how a scene will develop across a group of pictures. Again, AVC allows multiple motion vectors, as well as a greater range of both horizontal and vertical values, to significantly improve the accuracy of the predictions and thus improve the compression. By weighting the predictions, a well-designed AVC encoder can also perform much better on transitions that are traditionally tricky for encoders, such as crossfades and fade to black.

Entropy coding is at the heart of the MPEG algorithms. Entropy is defined as a measure of the degree of disorder in a system, and in image compression it is the technique by which the random elements of the picture are controlled. AVC adds several ways of managing entropy coding, including variable length encoding (as opposed to a structure based on 8-bit bytes), context-adaptive variable length encoding and context-adaptive binary arithmetic coding (CABAC).

CABAC is an auto-adaptive algorithm that can offer lossless compression of syntax elements in the video stream by knowing the probabilities of those syntax elements in a given context. This is widely used in AVC encoding, requiring considerable statistical analysis.

The standard also includes advances in resilience, including a network abstraction layer. By decoupling information relevant to more than one slice from the media stream, AVC can eliminate header duplication. This makes for more compact and stable data, deriving key information such as picture size, coding modes employed and the macroblock map

Whereas MPEG-2 uses one or at most two reference pictures in interframe coding, an advanced video codec permits the use of up to 16 frames.

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from self-contained packets in the network layer.

Other resilience measures include flexible macroblock ordering and data partitioning, which allows the separation of more and less important syntax elements into different packets of data. This in turn enables the application of unequal error protection, using the resilience overhead where it can be of greatest benefit.

The network abstraction layer is also the foundation for an important extension to the standard, codified in November 2007, which introduces scalable video coding. (See figure 2 below.) This creates a subset bit stream from the overall transmission by dropping packets. In turn, this means operators can be offered a reduced size or reduced frame rate service (perhaps for mobile devices) alongside a high-quality service, and within the same bit budget.

Finally, the standard allows for a number of profiles, which give the operator another way in which the delivered quality of experience can be fine-tuned. While initial interest in AVC was around the main profile, network operators are turning to the high profile to get better quality on-screen. Other profiles allow AVC to be used as a high-quality contribution or distribution algorithm, incorporating 4:2:2 color sampling and 10-bit video streams.

HDTV's mass take-up by consumers will depend on them perceiving that HD in the home is a visibly better experience.

Asymmetry

These are just some items from a long list of the added functionality in MPEG-4 AVC, and they are a real tribute to the visionary engineers who worked on the standard. Most important, they are all neces-

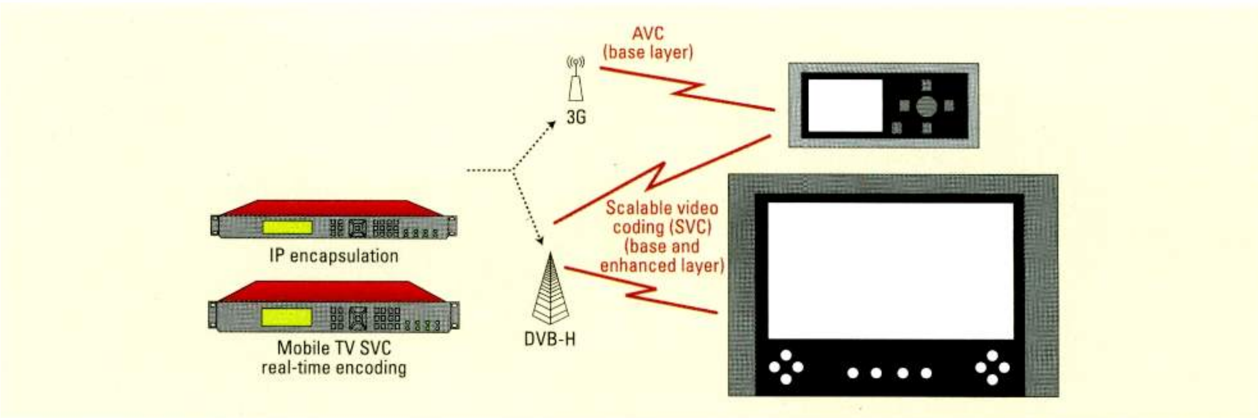

Figure 2. Real-time scalable video coding

sary if the target of equivalent or better quality in half the bit rate of MPEG-2 is to be achieved.

As mentioned earlier, MPEG compression algorithms are asymmetric. Here is another example of asymmetry. To achieve what is in effect a two-fold improvement in compression efficiency demands at least a 10-fold increase in processing power.

The traditional architecture of a transmission encoder uses standard DSP chips to provide the processing power. However, this is unlikely to deliver sufficient performance in an AVC encoder, due not only to the large number of complex processes required, but also because of the amount of memory reads and writes required.

The use of multiple reference frames for temporal compression, and the use of multiple motion vectors, calls for many frames to be held in memory and clocked through as required, sometimes at different rates.

In simple terms, handling the computational requirements and memory management demands would necessitate multiple DSPs. After a certain point, the overhead of the communication between DSPs and the bottleneck of transferring large amounts of data — video frames — around becomes a limiting factor, and further performance improvements become increasingly difficult.

The key

The solution is to develop a dedicated digital signal processing chip. Building a dedicated chip means that key processes can be handled onboard in application-specific hardware. Other processes can be undertaken by DSPs inside the chip. This gives the application designer the best of both worlds: the familiar programming environment and access to proven routines, with maximum speed from the direct access to other internal processes.

With high-speed I/O tailored to the requirements of high-bandwidth video streams, a single chip can support access to the full MPEG-4 AVC toolkit. And because it remains a software-driven device, it can be updated as improvements in algorithms appear, making the encoder or transcoder future-proof.

HDTV is being rolled out around the world, and its mass take-up by consumers will depend on them perceiving that HD in the home is a visibly better and more satisfactory experience than before. That is largely dependent upon the quality delivered by the encoder, which means it is vital for everyone to ensure that the best is made of the MPEG-4 codec. BE

Are Olafsen is the director of satellite DTH segment for Grass Valley.

Cross-country moves

Two stations ask to move from Nevada and Wyoming to compete in the Philadelphia and New York markets.

BY HARRY C. MARTIN

Two small Western-state TV stations have notified the FCC that they plan on moving from Nevada and Wyoming to Delaware and New Jersey, where they would compete in the Philadelphia and New York markets, respectively. Strangely enough, existing law may support these moves.

Background

When the FCC first allocated TV frequencies, only two states — New Jersey and Delaware — did not receive commercial VHF allotments. Recognizing this inequity, in 1982 Congress enacted Section 331(a) of the Communications Act, which mandates the FCC's policy to allocate commercial VHF TV channels such that "not less than one such channel shall be allocated to each state, if technically feasible." And if a commercial VHF licensee notifies the FCC that it is willing to have its channel moved to a community with no VHF commercial station, then the commission "shall" order the reallocation and grant the license modification.

The technical feasibility condition kept Delaware from obtaining any local VHF channels in the next 27 years due to the need to protect stations in nearby Baltimore, Philadelphia and New York. But in New Jersey, the owners of New York station WOR-TV, then on VHF Channel 9, were embroiled in a difficult license renewal contest. Taking advantage of Section 331, they asked the FCC to reallocate their channel from New York to Secaucus, NJ. This resolved the renewal problem, and New Jersey had its first commercial VHF TV station.

When the FCC first allocated TV frequencies, only two states — New Jersey and Delaware — did not receive commercial VHF allotments.

In reallocating TV channels for DTV, the FCC again did not allot any commercial VHF channels to New Jersey or Delaware. This meant that once the old Secaucus station moved from Channel 9 to DTV Channel 38, New Jersey would once again have no commercial VHF station, while Delaware never had one.

The proposal

Viewing these facts and law as an opportunity, an enterprising broadcaster bought VHF TV stations on DTV Channel 3 in the Ely, NV, population 4040, and DTV Channel 2 in Jackson, WY, population 9038. The broadcaster then notified the FCC that it wanted to move its two stations to Middletown Township, NJ, and Wilmington, DE, respectively, and asked for the license modifications necessary to accommodate the moves.

Operation of the stations in Middletown Township and Wilmington will not technically foreclose continued use of Channels 3 and 2 in Ely and Jackson. The commission could easily reallocate those channels back to the communities on a permanent basis. And it could grant interim operating authority to deserving "eligible entities" (small businesses) such as the ones the commission has been seeking to promote through its diversification initiatives. The proponent of the moves to Delaware and New Jersey has even offered to provide interim low-power TV service to Ely from an LPTV station it is acquiring in that market.

The FCC has yet to react to this proposal, but if it follows Section 331, Delaware will have its own full-power commercial VHF station for the first time, and New Jersey's full-power commercial VHF service will be restored. BE

Harry C. Martin is a member of Fletcher, Heald and Hildreth, PLC.

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

Dateline

- For noncommercial TV stations in Iowa and Missouri only, the biennial ownership report deadline is Oct. 1.
- Oct. 1 is the deadline for TV stations in Iowa and Missouri to electronically file their broadcast EEO midterm reports (Form 397) with the FCC.
- Oct. 1 is the deadline for TV stations licensed in the following states to place their annual EEO reports in their public files: Alaska, Florida, Hawaii, Iowa, Missouri, Oregon, the Pacific Islands, Puerto Rico, the Virgin Islands and Washington.
- Nov. 1 is the deadline for submission of biennial ownership reports for commercial TV stations in all states and territories.

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Multiplexing

VBR encoding can reduce needed bandwidth while supporting multicast applications.

BY ALDO CUGNINI

Last month, we explored various MPEG features, including constant bit rate (CBR) and variable bit rate (VBR) encoding. This month, we'll look at options for multiplexing video streams and dig a bit deeper into how VBR encoding can help with bandwidth utilization and multicast support.

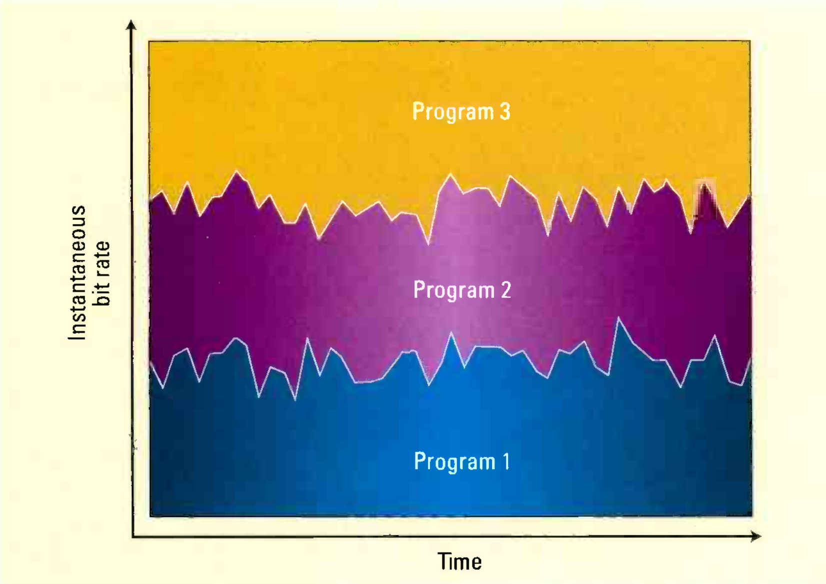


Figure 1. A stat mux using VBR can more efficiently allocate bandwidth in a fixed channel.

Bit allocation is an n-dimensional process

When encoding video, bits are assigned to pictures in many dimensions. Intracoded (I) pictures (or macroblocks) are used as references for other pictures (or other macroblocks, as in MPEG-4). The allocation of bits when encoding these pictures is a 2-D distribution over a picture: Different blocks will receive a different number of bits, depending on the regional complexity of the picture.

Intercoded (or nonintra) pictures (or macroblocks) comprise P- and B- pictures (or macroblocks) that are predictively coded or bidirectionally predictively coded from other I or P pictures. Assigning bits to these pictures and to their corresponding motion vectors then expands the total bit allocation to a 3-D distribution across multiple pictures, the third dimension being time. Different pictures will have a different number of bits, depending on the complexity within a sequence of pictures; a sequence with a strong scene change, for example, will get more bits than one with little motion.

Different blocks will receive a different number of bits, depending on the regional complexity of the picture.

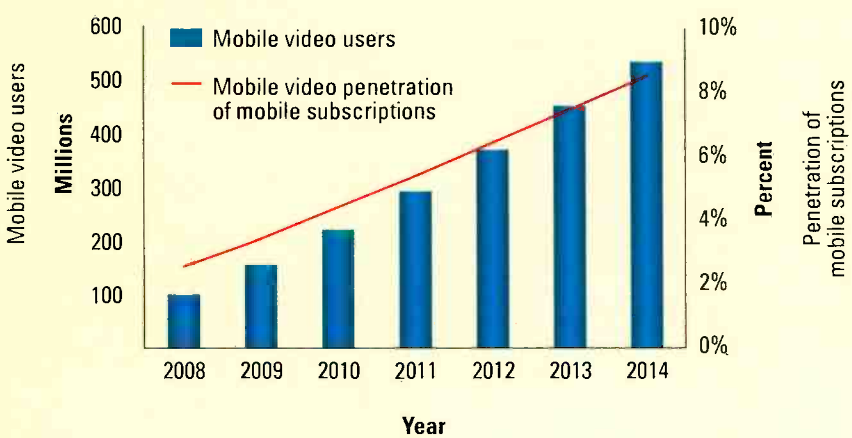
MPEG transport streams allow content providers to multiplex (mux) multiple video programs in

FRAME GRAB

A look at tomorrow's technology

Mobile video users and subscriptions increasing

Mobile video users are expected to reach 534 million by 2014.



Source: Pyramid Research *www.pyr.com*

one container that is sent within the transmission channel, usually as a transport stream. The simplest way to configure such a mux is to encode each program using CBR and to allocate a fixed bandwidth to each program. There is, however, a more efficient way to transmit a multichannel service by using statistical multiplexing (stat mux). By encoding each individual program using VBR, the bit rate of each program is allowed to vary, but the total bit rate across the program mux is held constant. (See Figure 1 on page 18.) Stat mux thus requires the distribution of bits over several programs — a 4-D bit allocation — and as such, the encoding algorithm is more complex than that for a single program or for a multiple-program CBR mux.

With CBR coding, more complex scenes get fewer bits than actually needed to avoid all artifacts, causing a related variability of picture quality. With VBR coding, all pictures are coded with a target of uniform quality, but with an associated variation in bit rate. This suggests that the combination of stat mux and VBR is a win-win situation. Research has shown that statistical multiplexing with VBR can provide the same video quality at 75 percent of the bit rate of a CBR mux. Put another way, for the same video quality, a stat mux can provide an increase of about 33 percent in the number of multicast channels available. This figure is called the statistical multiplexing gain (SMG), sometimes expressed in dB, and implies the number of channels available at peak bit rate demand vs. the number at the average (i.e., fixed) bit rate demand. Practice shows that this number is typically 30 percent to 40 percent, with the highest gain occurring when channels are subject to random insertion. This is to be expected, as the greatest gain happens when the demand is decorrelated among the programs.

By encoding each individual program using VBR, the bit rate of each program is allowed to vary, but the total bit rate across the program mux is held constant.

Nonetheless, if the channel demand is too aggressive, picture quality can still suffer. Compression encoders (and stat muxes) base their decisions on how to allocate bits on meeting a target of different parameters. When quality is one of these parameters, the encoders use what is called rate-distortion theory. The quality is gauged by measuring the distortion in the video, usually by estimating the difference between the uncompressed and compressed video, weighted by an estimation of the visibility of the distortion by observers. Basically, the encoder (or stat mux) sets a target for the bit rate and attempts to stay within this target, while at the same time trying to exceed a minimum quality level for the video by minimizing the coding distortion. Because viewers are sensitive to time-varying effects, the distortion must also be managed in a smooth manner; a stat mux similarly needs to maintain fairness over the different programs, lest demand on one affect the quality of others.

Mixing and matching: fixed and mobile video

Multiplexing over broadcast channels (multicasting) is essentially a time domain multiplexing (TDM) operation, wherein the different services are switched in time over the transmission channel. In practice, however, this must be differentiated from pure transport stream multiplexing, where the different services are contained within different packets, each with a corresponding packet identifier (PID), and all within the same modulation "layer." Because mobile services are inherently subject to a higher degree of multipath interference, programs destined for mobile reception must be delivered in a more robust transmission mode.

The various digital transmission systems in use throughout the world offer different modes for achieving this robustness improvement, but at a compromise in data throughput. When the main service and mobile services coexist on a single transmission channel, the various programs can be packaged within one stream, but the mobile services must be carried in a portion of the stream that is transmitted with a more robust modulation. (See Figure 2.)

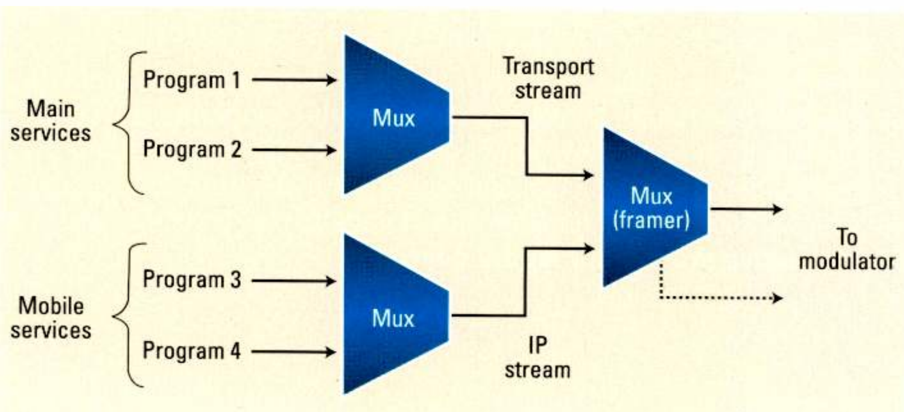


Figure 2. Mobile services are carried in an IP stream that is modulated with different parameters.

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With ATSC, mobile services are supported through a backward-compatible multiplexing scheme, called ATSC M/H or ATSC Mobile. Here, the main programs are carried within an MPEG-2 transport stream, and the mobile programs are carried within an IP stream. Both of these streams are then combined by means of a framing multiplexer that works in concert with the modulator so that the mobile services are modulated with more robust channel coding. The output of the framer, although not an MPEG-2 transport stream in the strict sense, nonetheless can be carried using standard transport interfaces.

DVB-H (for handheld) can similarly be combined with an existing DVB-T (terrestrial) service, with the main programs in an MPEG-2 stream, and the mobile programs encapsulated in an IP stream. Each stream is then modulated using different transmission parameters. With ISDB-T, the mobile stream is typically modulated onto a different set of carriers, with various modulation parameters, but these are interleaved with the carriers used for the main channel. ISDB-T also offers the use of one-segment (one-seg) services, where one group of contiguous carriers (out of 13 such groups) can be dedicated to a mobile service. The DVB and ATSC systems also provide what is called time slicing, a form of TDM, whereby the mobile data is transmitted in a way that allows the receiver to be switched off during the transmission of non-mobile data. The result is a significant power savings, an important feature for mobile (especially handheld) devices. (While ISDB-T does not use time slicing, the use of single-segment transmission will offer receiver power savings, as the transport stream data rate is lower.)

An important consideration is that when multiplexing the various programs, a stat mux usually will not be able to allocate bits across the fixed and mobile services.

An important consideration is that when multiplexing the various programs, a stat mux usually will not be able to allocate bits across the fixed and mobile services; i.e., while stat muxes could be used in either or both services, they can only allocate bits within each service, and not over the combination of both. This is because the total bit rate within each of the fixed and mobile muxes must be constant for the modulation (and receivers) to work properly. (Nonetheless, technology evolves, and a completely — or partially — dynamic service bit allocation could eventually be practical.) Using a VBR stat mux in the mobile service mux is an important consideration when trying to maximize the number of low-bandwidth programs and is an interesting option for maximizing the value of mobile services.

The use of MPEG-4/AVC also adds to the options available for multiplexing, but that's a subject onto itself. Stay tuned. BE

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Workflow for television

Be more efficient with a loosely-coupled design.

BY BRAD GILMER

Broadcasters are finding themselves in an ever-changing environment. Being able to meet the challenges these changes present is key to remaining relevant in a world increasingly dominated by alternative content delivery methods.

Traditional design methods are being challenged

A traditional facility might include a newsroom, a production facility and master control. Each area of the facility is provided with all of the technical elements needed in that area. For example, in a server-based facility, a newsroom feed recording area might have a dedicated server. The production facility would have dedicated edit servers; the same would be the case for master control. (See Figure 1.) In each of these areas, the servers perform the same function — recording and playing back video and audio. But the server might be used in different ways in each area: recording satellite feeds in the news area, acting as a source in the post area or playing back programming in master control.

Figure 1 illustrates a traditional stove-pipe design, dedicating transcoders, servers and other equipment to specific technical areas. This tightly coupled design style makes it difficult to adapt to changes in workflow. What happens when you add new functionality to such a facility? Or what happens when management requests the capability to feed mobile devices or to serve VOD content? Of course, broadcasters are already faced with these demands, and while they have not built parallel facilities for each new distribution outlet, they have tacked on pieces here and there to meet increasing demands. This approach works, but is there a new way of thinking that will allow broadcasters to respond more quickly to the changing competitive environment and make better use of the technical assets they already have?

Being able to meet the challenges these changes present is key to remaining relevant in a world increasingly dominated by alternative content delivery methods.

Loose coupling — a vital concept

Loose coupling is a concept that is used frequently in workflow design. It means that the function performed by a device is loosely coupled to the characteristics of the area in which that function is performed. This is a key concept in facility design because it allows you to start thinking about common functions and processes in your facility, and it allows you to use resources more efficiently. Furthermore, it enables you to design facilities in a way that makes changing the facility easier. For more information on loose coupling and other workflow terms, see the Advanced Media Workflow Glossary online at *wiki.amwa.tv*.

Let's look again at the concept of video servers in the television facility. Regardless of the area in which the server is deployed, the server's primary function is to record, store and play back video, audio and ancillary data and to receive and deliver video content as files. If a well-known and publicly defined network interface can be developed, then end-user devices such as newsroom feed clients can use the same servers as editors and master control automation devices.

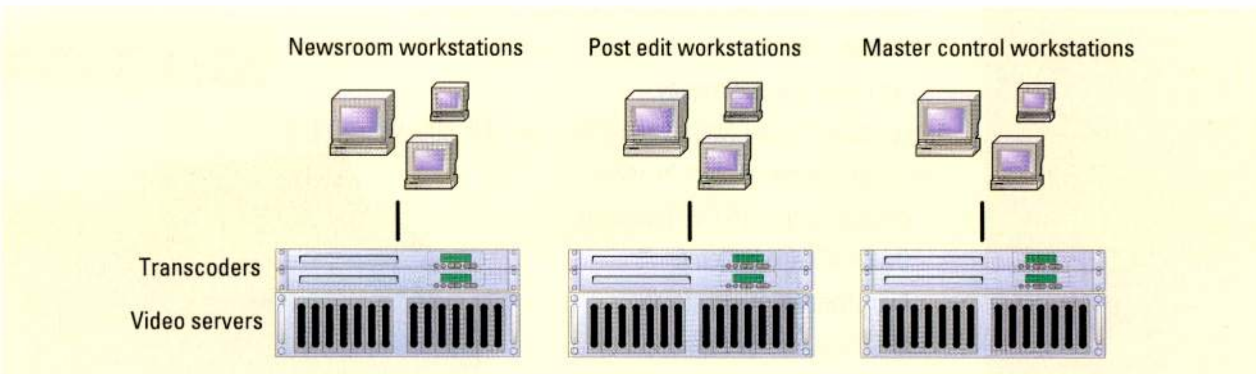
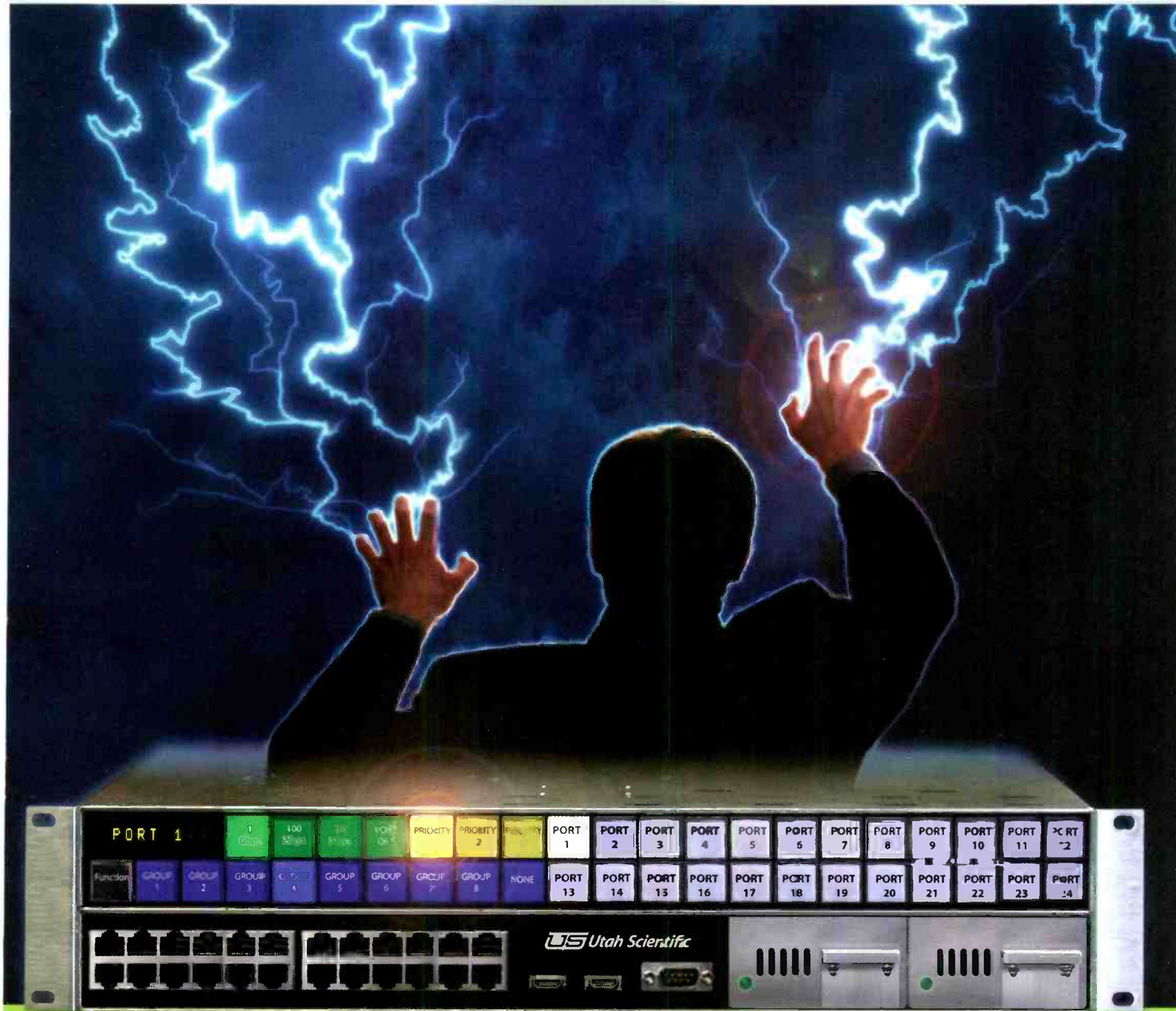


Figure 1. An illustration of a traditional stove-pipe design, whereby transcoders, servers and other equipment are dedicated to specific technical areas


PORT 1
Utah Scientific

Keeping it simple

While fully deploying workflow-based design in a television facility is a tall order, there is no reason you cannot begin to employ this way of thinking now. In fact, the concept of a centralized tape room in post and news facilities has been around for some time. In some ways, this was one of the first implementations of workflow-based facility design. It allowed the reuse of tape machines in different areas by recognizing that the function these machines performed was identical regardless of where they were being used.

As broadcasters move to file-based workflows, one of the challenges continues to be getting the video and audio into a format that the target device understands. For this reason, transcoding has become a fact of life in most television facilities. Many transcoding devices employ watched folders. Files placed in these folders are automatically picked up by the transcoder and converted from one file format to another.

You might not think of watched folders as part of workflow-based facility design, but they are. Transcoding is a function that is needed in many places in the television facility. If you followed the old model of facility design, each area — news, post and master control — might require its own transcoding facilities. But following a workflow-based model, a pool of transcoders could be made available on the network to any user needing that service, regardless of where they are located. In fact, the physical location of the transcoders is unimportant. Because the transcoding function is loosely coupled, it can be made available to new areas, as required. Also, loose coupling allows the broadcaster to add new transcoding capabilities to the facility without major re-engineering.

The same idea can be used with video servers. The video server service is used in many places in a facility. Is it possible to design a facility with centralized video server services such that the client requiring these services is loosely coupled to the device storing the video?

Figure 2 illustrates a redesign of the facility shown in Figure 1. Note now that transcode and video server services are offered to users across the network. Also, now fewer transcoders and video servers are deployed because redundancy has been eliminiated from the traditional design.

Common processes, common definition

The idea that a common set of processes are required in a number of different places within a facility is not new. In fact, many broadcasters have already analyzed their facilities, looking for common tasks across departments that are performed over and over again. In fact, the European Broadcast Union has conducted a study of common processes. This work is important because it identifies processes that can be optimized into service offerings, which can then be made available throughout the facility.

The next step in workflow technology is to move beyond watched folders and pooled tape facilities to

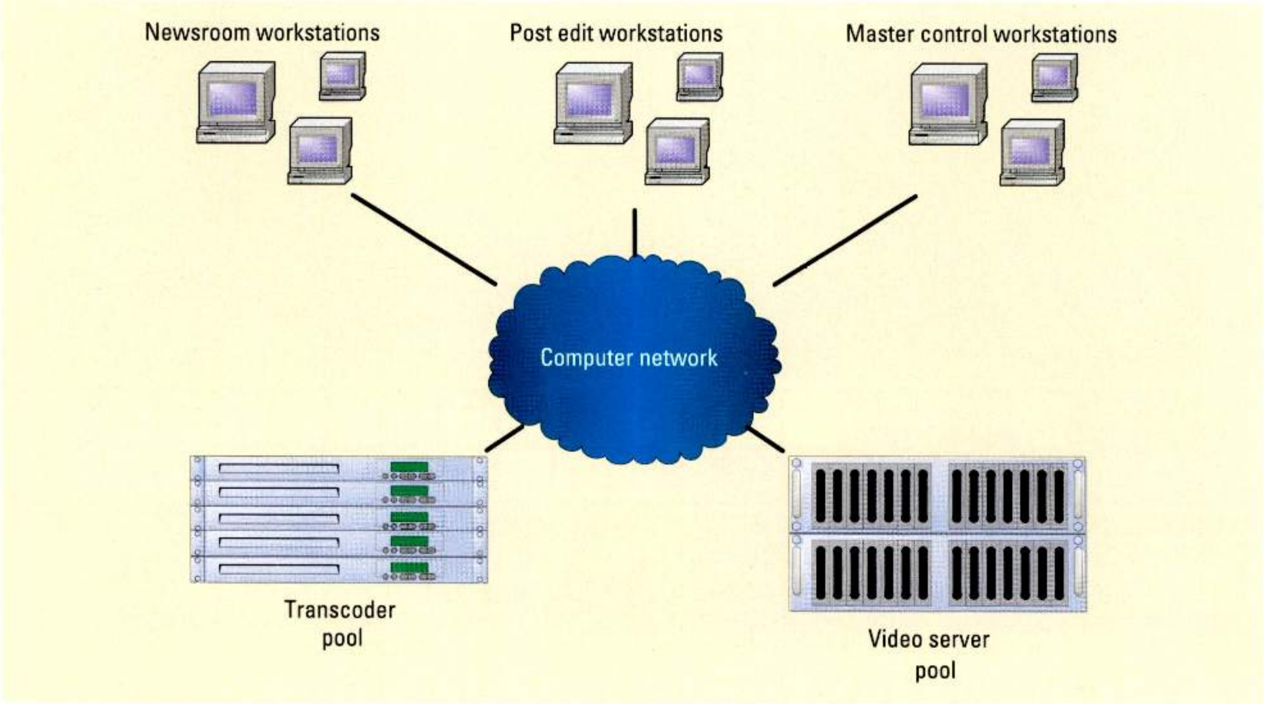


Figure 2. An illustration of a workflow-based design where clients access transcoding and video server services across a network

workflow-based facilities where services such as transcode and ingest are offered on the network to clients that need them. One way to develop such a system would be to have clients communicate with devices offering services through a countless number of proprietary APIs. This would work, but it would destroy the loose coupling that is at the center of workflow-based design. Each user would have to know the make, model and API software version of the transcoder they are trying to use. This is not the ideal solution.

A better way might be to develop a common language so that the services being offered can be described as such that anyone could write a description of the services, and any client could discover and use these services, regardless of the manufacturer. This is a lofty goal, but it has been achieved in other industries.

The promise — dynamic workflow reconfiguration

If common processes can be identified, and if the industry can reach a consensus on a way to define and use services, then the next logical step is to use workflow orchestration tools to redefine workflow processes on the fly. Imagine a workflow orchestration system that defines a workflow (ingest, edit, approve and move to air playout servers, for example) through a workflow diagram. A manager comes into your office with a new business plan that requires making video content available on the Web after it has gone through a separate approval process. In the future, it may be possible to add this new business to your workflow by editing the block diagram of your facility, adding the individual processes required (low-res ingest, Web approval, publish to Web). This is the promise of workflow-based facility design.

Practical considerations

Of course, this article has focused on the theoretical aspects of workflow-based design. For practical reasons, I suspect that master control will always have its own dedicated resources. Similarly, for technical or political reasons, news and post may also require dedicated resources. But it is important to realize that facilities can be designed differently from the way we have done it in the past. Doing so greatly increases our ability to respond to changes in the industry. BE

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

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Portable HD storage

Many alternatives to videotape exist, with price points for every budget.

BY DAVID AUSTERBERRY

Video acquisition is fast becoming tapeless, as camcorder manufacturers move toward alternative media formats. The optical disk, solid-state drive and conventional hard drive are all options that can replace videotape. The formats have advantages and disadvantages, and each has its proponents among camera manufacturers.

The lower cost camcorders that find applications in news, low-budget products or second units predominately record at 25Mb/s or lower. This data rate was adopted for the SD DV format; to support HD, they must use long-GOP coding and possibly MPEG-4 rather than MPEG-2 compression. The consumer HDV and AVCHD formats are representative. These camcorders usually include a 1394 or USB2.0 interface and can record to hard drives or Flash memory.

In contrast, broadcast HD cameras must record at higher data rates than 25Mb/s to deliver improved resolution and 4:2:2 color sampling. This means a move away from consumer recording formats to proprietary recording media, usually supplied by the camera manufacturer. The P2 and SxS solid-state media, plus the Professional Disc optical format, are representative of this class. To ensure the high levels of record reliability expected by broadcasters, the camcorders are designed as a system including the storage medium. Camera manufacturers supply a range of field recorders and drives to support viewing and file transfer at the shoot.

There is a third route: using portable storage with a separate camera rather than the integrated camcorder. This approach is best when high-quality recordings are needed, especially where extensive video processing is used in post production, including color grading and compositing.

To scope the requirements for portable HD recording, consider videotape. The longer S-size HDCAM-SR stores around 130GB of video data, and the full-size cassettes store up to 400GB of data.

The current optical disks and SSDs have a capacity of 50GB to 64GB but cannot match the 880Mb/s write speed of the tape. HDDs in compact and ruggedized formats for camera-top use are around 100GB, with record rates up to 100Mb/s. This will change radically over the next few years as the tapeless technologies evolve. The issues that constrain portable storage are size, weight, power consumption, resistance to vibration and, of course, cost.

There are two approaches to camcorder storage. The storage can be integral to the design, with a slot to insert the storage. The other approach is to attach a small drive between the battery and the camera, on top of the camera, where the microphone would sit, or underneath as part of the mount. This way allows tapeless recording to be used with existing DV format camcorders.

There are many third-party suppliers of this add-on storage. Some record DV-style at 25Mb/s, while others use codecs like JPEG2000 to offer high bit rates more suited to HD.

Optical disks

The Professional Disc that Sony's XDCAM product line uses incorporates similar technology to Blu-ray, but Sony has adapted the technology to suit the requirements of the broadcast camcorder. The Professional Disc is supplied in a caddy to protect it from handling. The disk carries a low-res proxy file in addition to the broadcast resolution file. This can be used in the field for logging and preview.

The AJA Ki Pro field recorder can be used with a regular HDV camcorder. It records to a 250GB HDD with the option to fit SSDs.

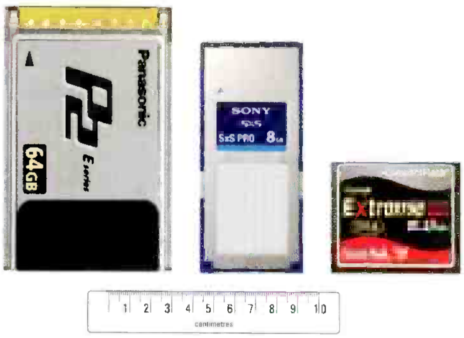
For HD recording, the XDCAM format uses MPEG 4:2:2 or 4:2:0 encoding at data rates up 50Mb/s. Using the dual-layer 50GB disk at 50Mb/s, the record time is 95 minutes.

Solid state

The original broadcast format is Panasonic's P2 card. This can record at data rates up to 100Mb/s. The card capacity grows year by year, with 64GB cards available in 2009. P2 camcorders record HD using the DVCPRO HD codec, or more recently in the AVC-Intra format, which offers higher quality for a given bit rate. The record time is one minute per GB, or 64 minutes for the 64GB card.

Sony now has a solid-state format, the SxS card, which it developed with SanDisk. It is based on the footprint of the ExpressCard 34 PC card for laptops. With a current capacity of

No Signal? No Audience!



Solid-state memory cards have become a popular way to acquire HD video. Shown to scale are the Panasonic P2, Sony SxS and SanDisk Compact Flash.

32GB, it is used by the XDCAM EX cameras, recording MPEG at 35Mb/s. JVC also has adopted the format.

Ikegami has developed a Flash memory pack for its GFCAM HD camcorder. The GFPAK memory is available in capacities up to 64GB, and it uses a SATA interface.

Hard drive

The Grass Valley Infinity is based on the RevPro removable magnetic media, but it can also record to CompactFlash. The camera operator can choose what is appropriate for the project. RevPro disks have capacities up to 65GB, and the camera records with a wide range of codecs, including 10-bit JPEG2000 at up to 100Mb/s.

Card or drive?

There are two families of solid-state memories. One is aimed at the HDD replacement market as a solid-state drive (SSD). A typical commodity SSD has SATA connections so that it can be used as a drop-in replacement for an HDD. Designed for laptops with the same low power and small size requirements as a camcorder, they are naturally rugged. Some video SSDs may have 1394 connectors, so they can directly connect to HDV camcorders.

The other family is the memory card, typified by CompactFlash (CF) and Secure Digital (SD). Aimed at the consumer market, these products do not generally have the performance required for reliable HD capture.

High-quality capture

Many of the portable formats designed for use in camcorders use long-GOP compression for HD to reach the low data rates that can be continuously written to current Flash memory technology. The P2 card uses striped memory modules to reach 100Mb/s data rates, sufficient to support I-frame encoding of HD.

If you want to shoot 4:2:2 or 4:4:4, with minimal compression, possibly at 10-bit resolution, the benchmark is the HDCAM-SR, with a record data rate of 880Mb/s in the high-speed mode. The alternative to a tethered VTR is to use a portable hard drive array. Several manufacturers supply such systems for the digital cinematography market. Such units may be

Media	Technology	Suppliers	Capacity	Typical data rate	Record duration
CompactFlash	Flash	many	32GB	100Mb/s	32 minutes
GFPAK	Flash	Ikegami/Toshiba	64GB	100Mb/s	60 minutes
P2	Flash	Panasonic	64GB	100Mb/s	64 minutes
Professional Disc	Optical	Sony/TDK	50GB	50Mb/s	95 minutes
Rev Pro	HDD	Thomson Grass Valley/Iomega	65GB	100Mb/s	60 minutes
SxS	Flash	Sony/SanDisk	32GB	35Mb/s	100 minutes

Table 1. A comparison of tapeless onboard storage formats. Note: The capacity of the media is constantly increasing, so the figures here were representative in August 2009.

DC powered, with the ability to record dual link HD-SDI as well as 4K signals via an optical connector. The drives are encased in rugged caddies and can be delivered to post in much the same way as a videotape.

Which medium is best?

Each recording technology has pros and cons. (See Table 1.) Solid-state cards and drives are rugged and shockproof, but currently are expensive. They are best suited to use as a temporary cache, rather than an archive format. Optical disks are low cost and can be used for the long-term archive of a production. Hard drives are low cost, but not ideal for use as a permanent archive (more than five years).

Other considerations relate to workflow. What equipment do you need to preview rushes? If you need to archive expensive cards for reuse, what is needed at the shoot to perform the backup? What about copies for escrow to meet the requirements of production insurance?

What may be the optimum medium for news acquisition is not necessarily best for a drama shoot. Tapeless recording presents a wide choice, with price points for every budget. **BE**

Fiber-optic terminations

Follow these procedures to create low loss and reliable terminations.

BY JIM HAYES

Probably no fiber-optic component has been given greater attention than connectors. Searching for lower loss and easier installation, manufacturers have created more than 80 styles of connectors and about a dozen different ways to install them. Fortunately, only a few types are used for most applications. In the United States, those are the SC, ST and LC connectors. And they are now as easy to install as many copper connectors.

Optical loss is the most important characteristic of a fiber-optic connection. A single connector does not have loss per se, since loss is caused in the mating of two connectors, both of which contribute to the loss in the connection. The optical loss of a connection is a function of the precision of the alignment of the two fibers, both lateral and angular, and the quality of the finish on the end of the fiber. The reflectance of a connection, which is also important, especially in high-speed systems, is a function of how well the ends of the connector mate and the quality of the end finish. Connection performance is determined by both the precision of the connector itself and the quality of the polishing during the termination process.

Shown here, from left to right, are SC, ST and LC connectors.

Optical loss is the most important characteristic of a fiber-optic connection.

Most connectors available today use ceramic ferrules to hold and align the fibers. Ceramic is used because it adheres well to glass, is easy to polish and has low thermal expansion like the glass fiber. The end of the ceramic ferrule is domed to ensure the fibers make good contact. These are known as physical contact (PC) connectors. Another type of connector used in single-mode systems, angled PC or APC, has the dome at a small angle to the axis of the fiber to further reduce reflectance. APC connectors are used on most CATV and many other high-speed systems.

Installing connectors

Most connectors are attached to the fiber by an adhesive and polished to a fine finish. Factory-made cable assemblies, patch cords and pigtails (a connector on one end of a simplex cable and bare fiber on the other end) are mostly made using a heat-cured epoxy adhesive and polished on automatic machines to get a consistent fine finish.

Field terminations can be made using similar adhesive/polish techniques, splicing preterminated pigtails onto the fibers or attaching prepolished/splice connectors. Some installers do no field terminations at all, preferring to purchase prefabricated cable systems, which require only installation and testing.

Splicing pigtails on cables

Most single-mode field terminations are made by splicing a factory-

FRAME GRAB

A look at the consumer side of DTV

Percent of homes completely unready for DTV transition

1.5 percent of the TV viewing market is unprepared for DTV.

Date	Total	White	African American	Hispanic	Asian	Under 35	Over 55
June 28, 2009	1.5	1.1	3.5	2.3	2.5	3.5	0.6
June 14, 2009	2.2	1.6	4.6	3.6	3.2	4.4	1.1
May 10, 2009	2.9	2.3	5.7	4.9	3.4	5.4	1.6
April 12, 2009	3.2	2.5	5.9	5.4	4.3	5.9	1.7
March 15, 2009	3.6	2.9	6.6	6.1	4.4	6.5	2.0
February 15, 2009	4.4	3.6	7.5	7.4	5.1	8.1	2.6
January 18, 2009	5.7	4.6	9.9	9.7	6.9	8.8	4.0
December 21, 2008	6.8	5.6	10.8	11.5	8.1	9.9	5.2

Source: The Nielsen Company *www.nielsen.com*

made pigtail onto each fiber in the cable being installed. Termination of single-mode fiber is more difficult than multimode fiber because the smaller core requires greater precision in components and processes. Reflectance is also a problem with single-mode systems, so the end of the fiber must be carefully polished, which is difficult with hand-polishing. Single-mode connectors are usually machine-polished using diamond polishing film and a polishing slurry to get the smooth finish needed. These precisely made connectors are then fusion-spliced onto each fiber for minimal loss.

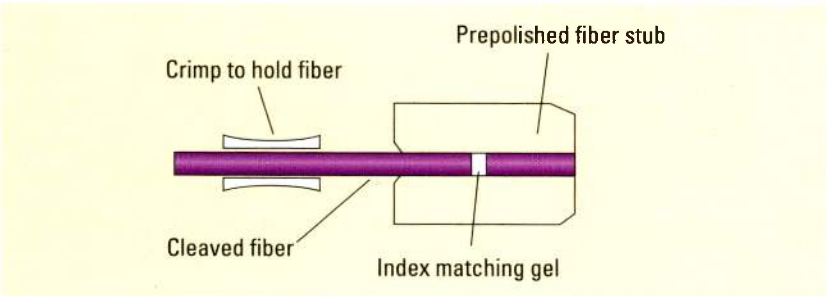


Figure 1. Prepolished/splice connectors have a short fiber stub glued inside the connector.

Prepolished/splice connectors

Prepolished/splice connectors have a short fiber stub glued inside the connector that has been polished at the factory. (See Figure 1.) These connectors are like a short pigtail, except the end of the fiber that is spliced to the fiber being terminated is inside the connector. To attach the connector, one strips and cleaves the fiber, a process that involves creating a clean end on the fiber with a special tool, inserts it in the connector and crimps it in place. Having both a splice and a connection loss means these have higher loss than adhesive/polish connectors, but they can produce acceptable results.

Prepolished/splice connectors are more expensive due to the inclusion of a splice in the connector and the more complex manufacturing process. Toolkits to install them are also more expensive than adhesive connectors. However, they are quick to install so the labor savings may offset their higher costs.

Adhesive/polish connectors

Most connectors use adhesives to hold the fiber in the connector and polish the end of the fiber to a smooth finish. While this may sound like a time-consuming process, an experienced installer can install connectors in less than a minute and get extremely low optical loss. There are three common types of adhesives: epoxy, Hot Melt and anaerobic.

Most connectors, including virtually all factory-made terminations, are the epoxy/polish type where the fiber is glued into the connector with epoxy. The epoxy is injected into the connector before the prepared fiber is inserted. The adhesive can set overnight or be cured in several minutes in an inexpensive oven. The small bead of hardened epoxy that surrounds the fiber on the end of the ferrule makes the polishing processes much easier — practically foolproof. This process provides the most reliable connection, lowest losses and lowest costs, which is especially important if you are doing a lot of connectors.

Hot Melt is a 3M trade name for a connector that already has the adhesive (a heat set glue) inside the connector. The connector is placed in a hot oven, where the glue is melted in a few minutes. When the glue is melted, insert a prepared fiber into the connector, let it cool, and it is ready to polish. The Hot Melt is fast and easy, has low loss, but is not quite as cheap as the epoxy type. Hot Melt connectors require a special oven, as they need a much higher temperature than is used for curing epoxy.

Anaerobic adhesive connectors use a quick-setting anaerobic adhesive that cures faster than other types of adhesives. Various techniques of

While this may sound like a time-consuming process, an experienced installer can install connectors in less than a minute and get extremely low optical loss.

Figure 2. The termination process

applying adhesive are used, including injecting it into the connector before inserting the fiber or simply wiping adhesive onto the fiber before inserting it in the connector. These adhesives dry in five minutes alone or in 30 seconds when used with a chemical accelerator.

It's important to follow termination procedures carefully, as they have been developed to produce the lowest loss and most reliable terminations.

The termination process

For all types of adhesive/polish connectors, the termination process is similar. (See Figure 2.) Start by preparing the cable, stripping off the outer jacket and cutting off strength members. Next, strip the fiber with a special tool that removes the plastic buffer coating without damaging the fiber. Then clean the fiber, and set it aside. Apply adhesive to the connector or fiber, and insert and crimp the fiber into the connector body.

After the adhesive is set, the fiber is then cleaved close to the end of the ferrule. Polishing takes three steps. First, air polish to grind down the cleaved fiber to near the end surface of the ferrule. Then polish on two different grades of abrasive film placed on a rubber pad using a polishing puck to keep the fiber perpendicular to the surface.

The process takes longer to read about than actually do. An experienced installer can terminate multifiber cables in about one minute per fiber, using the time required to cure the adhesive to prepare other connectors and reduce the time per connector.

It's important to follow termination procedures carefully, as they have been developed to produce the lowest loss and most reliable terminations. Use only the specified adhesives, as the fiber-to-ferrule bond is critical for low loss and long-term reliability. And, like everything else, practice makes perfect! **BE**

Jim Hayes is author of "The Fiber Optic Technicians Manual" and co-author of "Data, Voice and Video Cabling." He currently serves as president of the Fiber Optic Association.

Monitoring technology

Ensure quality and compliance by leveraging the A/78 and SCTE-142 recommended practices.

BY RICH CHERNOCK

The TV industry has made a major transition from analog to digital. Systems monitoring has undergone a similar transition and has become significantly more important for successful operations. In the analog monitoring model, simply watching video and audio on a monitor qualified as a sufficient monitoring strategy. If problems were evident on-screen, it was easy for the engineer to correlate the symptom with a cause. With DTV, however, that clear understanding of cause and effect has vanished.

Now, as broadcasters send data through computers and use software programs to calculate TV signals, they face a much more complex challenge in ensuring the quality of their output. Because different receivers rely on different versions of software to process the DTV signal, a single issue in the stream may result in a variety of behaviors. In other words, the receiver doesn't work as a monitoring tool; more sophisticated monitoring technologies are required.

In the digital realm, any given symptom can come about through any number of sources. Tiling, packet loss, continuity errors, program clock reference (PCR) issues, problems with the timeline and buffer issues are among the many symptoms that might arise, and none of these form one particular problem. Given the new complexity of managing DTV signals, it is imperative that broadcasters have the tools and technology to understand what's going on in transport streams, be able to locate the problem and then isolate the system that caused it.

Monitoring compressed media content

Only by looking at all aspects of the MPEG transport stream, or compressed media content, can broadcasters ensure that they are both meeting industry standards for DTV delivery and providing their customers with a high QoS. A comparison of transport stream elements and parameters against industry standards can enable identification of noncompliance or other issues; however, without a sophisticated means of applying industry standards, broadcasters can

Figure 1. DTV carriage auditing showing reduced bit rate

be overwhelmed by the volume of stream errors identified.

It is the nature of DTV that there is virtually always something technically wrong with the transport stream. While broadcast devices can introduce error, the standards themselves often come into conflict and cause errors, or "collisions." A classic example of this phenomenon occurs when the program association table (PAT) must appear at set time intervals and the PCR must appear in every video frame. The multiplexer combining these different streams of packets into one continuous stream is often forced to choose which rule to follow. Because the PCR is more important, the multiplexer will always choose to delay the PAT. While this situation technically creates an error and a change to the PAT that may alter channel tuning time, the overall impact is imperceptible to the viewer. The engineer doesn't need to be alerted each time this issue occurs.

A comparison of streams across the facility helps to isolate the device that introduced the error.

Sophisticated monitoring technologies leverage the A/78 and SCTE-142 recommended practices to identify and prioritize transport stream errors and, by placing the focus of monitoring on nontrivial errors, simplify the work of engineers in managing DTV service quality. With the ability to recognize noncompliance in real time and filter specific errors, broadcasters can be sure that they are informed immediately of serious problems, while less serious issues are logged for later investigation.

A/78 and SCTE-142 outline seven categories of transport stream error types: PSI errors, out-of-band table errors, in-band table errors, PSIP errors, timing and buffer errors, consistency errors, and general errors. To each of these, the standards apply five levels of severity: transport stream off-air (TOA), program off-air (POA), component missing (CM), QoS and technically nonconformant (TNC). With errors differentiated first by their impact on the viewer experience, engineers can be proactive in addressing transport stream issues — and the root causes — that most directly threaten customer satisfaction. These filtering concepts allow rules-based monitoring systems to be particularly effective in allowing operators to maintain their quality objectives. (See Table 1.)

Error condition	Error qualifier	TOA	POA	CM	QoS	TNC
PAT repetition error	PAT repetition interval error (found between the last 101ms and 200ms)					X
PAT repetition error	PAT repetition interval error (found between the last 201ms and 500ms)				X	X
PAT absence error	PAT not found for 501ms (or longer)	X	X	X	X	X
PAT syntax error	Packet with PID 0x0000 doesn't have table_id 0x00	X	X	X	X	X

Table 1. Examples of A/78 PAT error conditions

Measuring internal and external streams

While monitoring within the broadcast plant tends to be more straightforward than across a cable operation, there are several different points in the transmission chain to which broadcasters should pay attention. The proper location of monitoring systems helps engineers localize impairments and quickly move on to troubleshooting and resolution of the underlying problem.

Though the ideal solution would involve the placement of monitoring systems "behind" every device that manipulates, modifies or otherwise processes the transport stream, in reality, the installation of monitoring systems at all points that impact the digital signal is not a feasible option for most broadcasters. Instead, they can position monitoring equipment strategically, and even implement portable systems, to uncover stream impairments at critical points in the broadcast plant. Real-time monitoring of the MPEG layer across these points offers the engineer a means of identifying suspect transport streams and narrowing the problem area. A comparison of streams from locations across the facility thus helps to isolate the device that introduced the error. Monitoring systems with integrated logging and trend analysis tools provide a broader and deeper look at transport stream issues, and this capability can be critical in identifying and resolving recurring problems.

The internal monitoring of transport streams ensures that over-the-air broadcast viewers are receiving compliant DTV signals, but effective monitoring of streams carried by a cable provider or other downstream infrastructure also is critical to successful carriage agreements. Regardless of how they receive a particular channel, audiences often associate video and audio quality with the program, channel or network they're watching rather than with the service provider.

The ability to automatically compare transport streams at different locations (DTV carriage auditing) allows a broadcaster to determine if impairments are introduced by a downstream system. (See Figure 1 on page 6.) Broadcasters invest heavily to produce high-quality programming, increasingly in HD. When that content leaves the broadcast plant, it is subject to the decisions made and devices used by the downstream operator. Placement of a stream monitoring system on the multiplexer output can enable comparison with the QAM output from the cable headend, for example, and in turn allow measurement of the QoS being provided. From the cable operator's perspective, the ability to validate MPEG transport characteristics and the presence of accurate PSIP metadata within the incoming stream also ensures that it can be carried successfully through the cable plant.

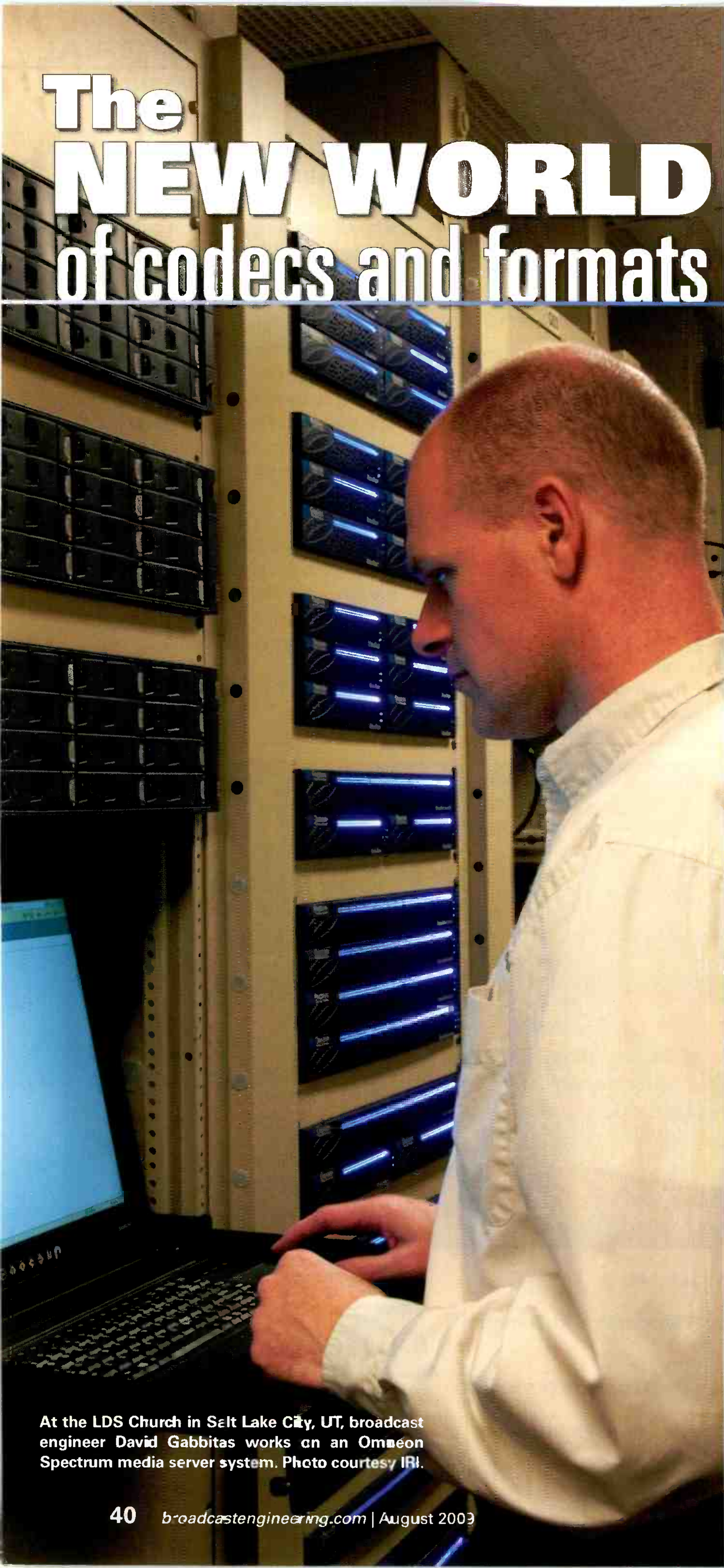
> **Audiences often associate video and audio quality with the program, channel or network they're watching rather than with the service provider.**

Maintaining quality and competitiveness

Effective monitoring of DTV streams according to current industry standards is vital to the broadcaster's ability to provide continuous, consistent QoS. With properly positioned monitoring solutions that are sufficiently sophisticated to identify and report transport stream issues according to these standards, engineers in the broadcast plant can be efficient and effective in maintaining stream quality and, in turn, preventing viewer complaints.

A/78 and SCTE-142 provide a framework that advanced monitoring systems can use to ensure this quality. Broadcasters who implement these technologies stand to gain both a competitive edge and peace of mind. BE

Rich Chernock is chief technology officer at Triveni Digital.



The NEW WORLD of codecs and formats

BY PAUL TURNER

It's widely understood that file-based operations inherently are more efficient. A closer look at the typical workflow, however, reveals that while file-based processing, storage and movement of media offers opportunities for streamlining operations, it takes back some of that efficiency by forcing system designers and manufacturers to deal with the huge, growing range of individual codecs used by the different systems and areas of production, preparation and distribution that make up any broadcast workflow.

For decades, baseband analog video and audio were the well-specified, documented and accepted standards among broadcasters for material exchange. As a result, getting media from point A to point B was a straightforward and understood proposition. Little, if any, thought was given to what happened to video within a processing box; it was completely isolated and its internal format irrelevant. As long as a system could accept and output video and audio in the accepted format, it could serve as an island of processing within the larger workflow. The initial move to digital video and audio did nothing to change this. As long as the processor provided adequate picture quality and the required input and output formats, the internal codec was of little interest to the system designer. The transition to file-based workflows is changing all of that.

File-based workflows: New considerations

Notable efficiencies can be gained by passing material from one processor to another in compressed form. System latency can be significantly reduced as, given a specific transfer bandwidth, compressed media can transfer at many times faster than real

At the LDS Church in Salt Lake City, UT, broadcast engineer David Gabbitas works on an Omneon Spectrum media server system. Photo courtesy IRI.

time. End-to-end picture quality can also be improved by avoiding multiple decompress/transfer/compress stages as media passes through the workflow — at least in theory!

Unfortunately, this last point leads to new concerns for the system designer and equipment manufacturer. Because no single codec is optimal for all of the processes in the system, the system designer must now understand the pros and cons of each of the codecs involved in the various processors that make up the signal path, not only to decide intelligently which codecs should be used at each step, but also to understand the number of transcodes/rewraps that may be necessary to convert files throughout the various steps in the workflow — even if these transcodes/rewraps occur internal to an individual manufacturer's equipment.

Compression: Not "one size fits all"

No single codec is perfectly suited to all workflow tasks. Consider, for example, two basic stages in a broadcast workflow: editing and playout.

Editing is a creative process in which individual elements are stitched together to tell or modify a story. The ability to cut between takes on any frame boundary is a prerequisite of this stage, and intraframe (I-frame) compression is the method of choice, regardless of whether the compression engine is DV, DVCPRO HD or I-frame MPEG-based.

Playout is much more a mechanical exercise. Finished material is transferred to the playout server and played out at the right time under automation control. Playout servers are generally multichannel devices that use high-performance disk drive systems. Because of the high cost of the storage systems, it is desirable to store as much material as possible on those drives while giving multiple channels simultaneous access to that material. As a consequence, interframe (long-GOP) compression is the method of choice, again regardless of the compression engine.

There is an obvious conflict. Two different (though related) compression techniques are being used, and each is optimal for its workflow stage, but not for the other. So, the designer has two choices: decide on a single format and accept suboptimal performance in one operation, or use both codecs with a transcode stage sitting between them.

The first approach usually resolves to the use of I-frame compression on the playout server. Most manufacturers support this model, but the penalty is slower transfer between stages (as the files are physically larger) and a reduction in storage efficiency on the playout server. The second approach allows each stage to be maximally efficient and, depending on the location of the transcode (pre- or post-transfer), can improve transfer efficiency. This model, however, also adds a latency penalty to the overall workflow based on the time taken to transcode any particular clip.

Clearly the broadcaster, system designer and equipment manufacturers all need to be aware of the pros and cons to each codec and transcoder in order to specify and deliver the most efficient design. Broadcasters need to understand where any compromises may be, system designers need a comprehensive understanding of codecs and latencies, and equipment manufacturers need to design their equipment to give broadcasters and designers the greatest range of choices when creating a system. This is a never-ending activity, as there is no shortage of new codecs being announced every year.

Wrapper and file structure

Like compression technique, both the wrapper and basic file structure have significant implications for efficient media transfer, and these must be carefully considered as part of the system design and file-based workflow. The first question should be whether to use self-contained files or reference files — both supported in QuickTime and MXF — at any particular stage.

Figure 1. Self-contained file

A self-contained file includes both the essence and the metadata, so there is a single entity to be transferred from one location to another. (See Figure 1.) Self-contained files are perfect for content distribution and remote playout scenarios because of the simple transfer mechanism required. However, because they need to be disassembled prior to manipulation, they are not so appropriate if any kind of media processing is required at either end of the transfer. Reference files are more appropriate for that part of the workflow.

A reference file is made up of the media files themselves, plus a wrapper file that contains metadata and pointers to the media. When an application tries to play the file, it accesses the reference file to discover which essence files to play as part of that clip. (See Figure 2 on page 44.) This is the file type of choice for editing, language addition, closed-captioning addition, and other applications that modify or add tracks to a clip. No disassembly or reassembly of the file is required. FTP file transfers are more complex, though, as the transferring application must understand exactly which files are pointed to by the reference file in order to ensure that all media necessary for clip playout is transferred as part of the FTP session.

It is, of course, possible to rewrap reference files, converting them from self-contained to reference,

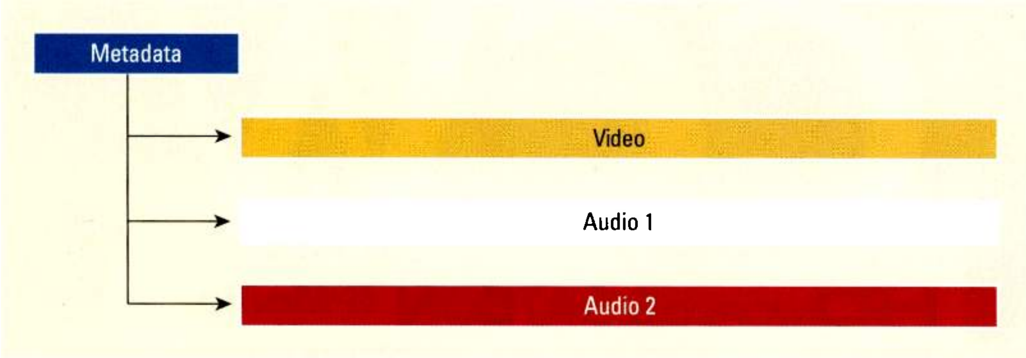


Figure 2. Reference file

QuickTime to MXF and vice versa. This is a less-complicated activity than transcoding the essence and can therefore happen much faster, but it still has implications for the overall latency of the system.

Latency, codecs and file formats

Several broadcast workflows are relatively impervious to system latency considerations, as they include plenty of time to QC, prep and regionalize the material before playout, and then transcode/rewrap content. Other workflows, such as news and sports highlights, demand extremely short end-to-end (shoot-to-show) latencies. Paradoxically, while these are the most likely to benefit from the efficiencies of file-based workflows, they are the least tolerant to the file conversions involved that, by their very nature, slow down the flow of media.

The goal, then, is to minimize the transcode/rewrap stages in these workflows and to make those transcodes as efficient as possible. One simple way of achieving this is to choose the edit codec so that field material can be shot using that codec and then be edited natively on the NLE of choice. Because many playout servers can natively accommodate multiple codecs, a transcode stage can be avoided by careful equipment and codec choice. The downside is that this may limit the total number of channels supported by the playout server — something that should be recognized when the system is designed.

The issue of file structure still remains, however. Low-latency workflows often require the ability to operate on a clip during transfer. Moving a clip from ingest server to editor while it's still being ingested (and making all of the currently ingested material available to the editor on an ongoing basis) is one common example, often referred to as transfer while record. Another example is the need to play out a clip while it is still being transferred to the playout server, or play while transfer. File structure plays an extremely important enabling role in these scenarios.

Many on-disk file formats are written in a non-left-to-right manner in which the header is written to disk and, as material is added to the file, updated constantly to reflect the current state of the file. Such a piece of metadata might be the clip duration. Initially set as part of the first write of the file, the duration is continually updated as material is added. If the clip is considered as a timeline, it is clear that the writing of the file is not left-to-right, as the system is continuously updating the left end of the file. (See Figure 3.) This can be problematic for FTP file transfer. The receiving device will only know the duration of the clip, for example, as identified at the start of the transfer. To resolve this problem, special techniques can be invoked whereby the transmitting system knows that it must keep transmitting new versions of the header part of the file at some regular interval. The receiving system must then integrate that new header information into its own copy of the clip.

The solution to this dilemma is to use files that are written strictly left-to-right. Once a piece of data is written, it is never rewritten. As much header data as is known to be valid and nonchangeable at the time the clip recording started is stored in the header. A flag is set to indicate that this file has incomplete metadata in the header and that the full, valid metadata will be written at the end of the clip. (See Figure 4.) In this way, the clip can be transmitted as it is being written without any concern that a piece of metadata may be out of date. The receiving system has sufficient information (clip name, etc.) at the start of the clip to initialize the clip in its own database, and material will continue to stream in via the transfer mechanism. Final metadata is provided at the end of the clip when recording has completed.

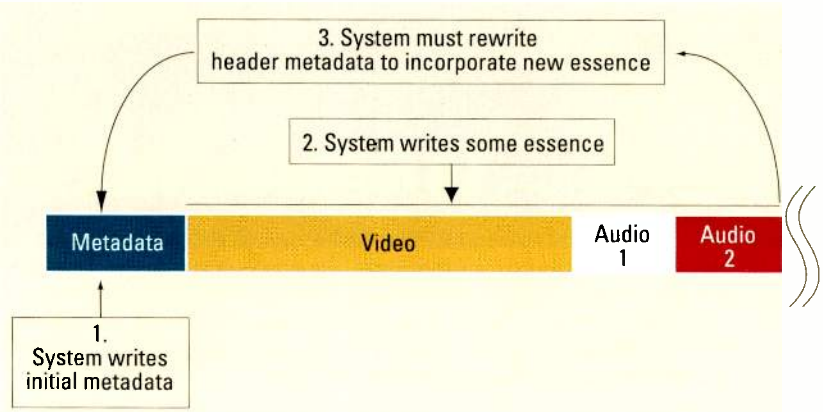


Figure 3. Non-left-to-right files

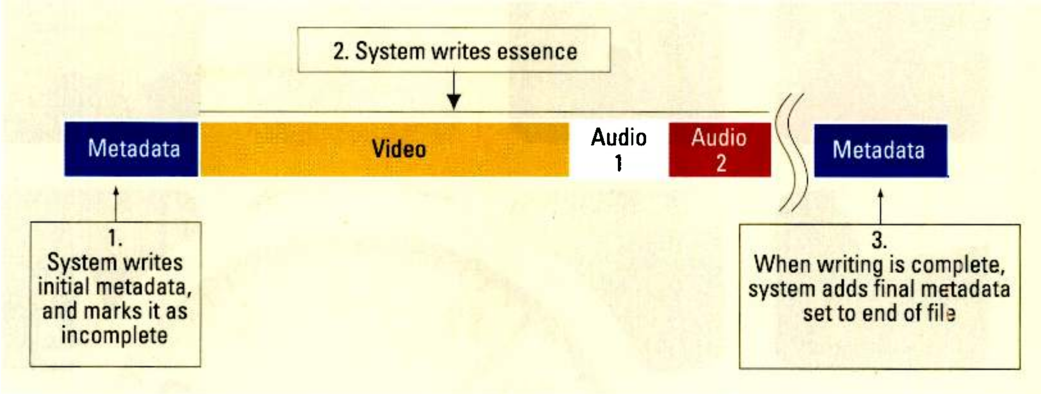


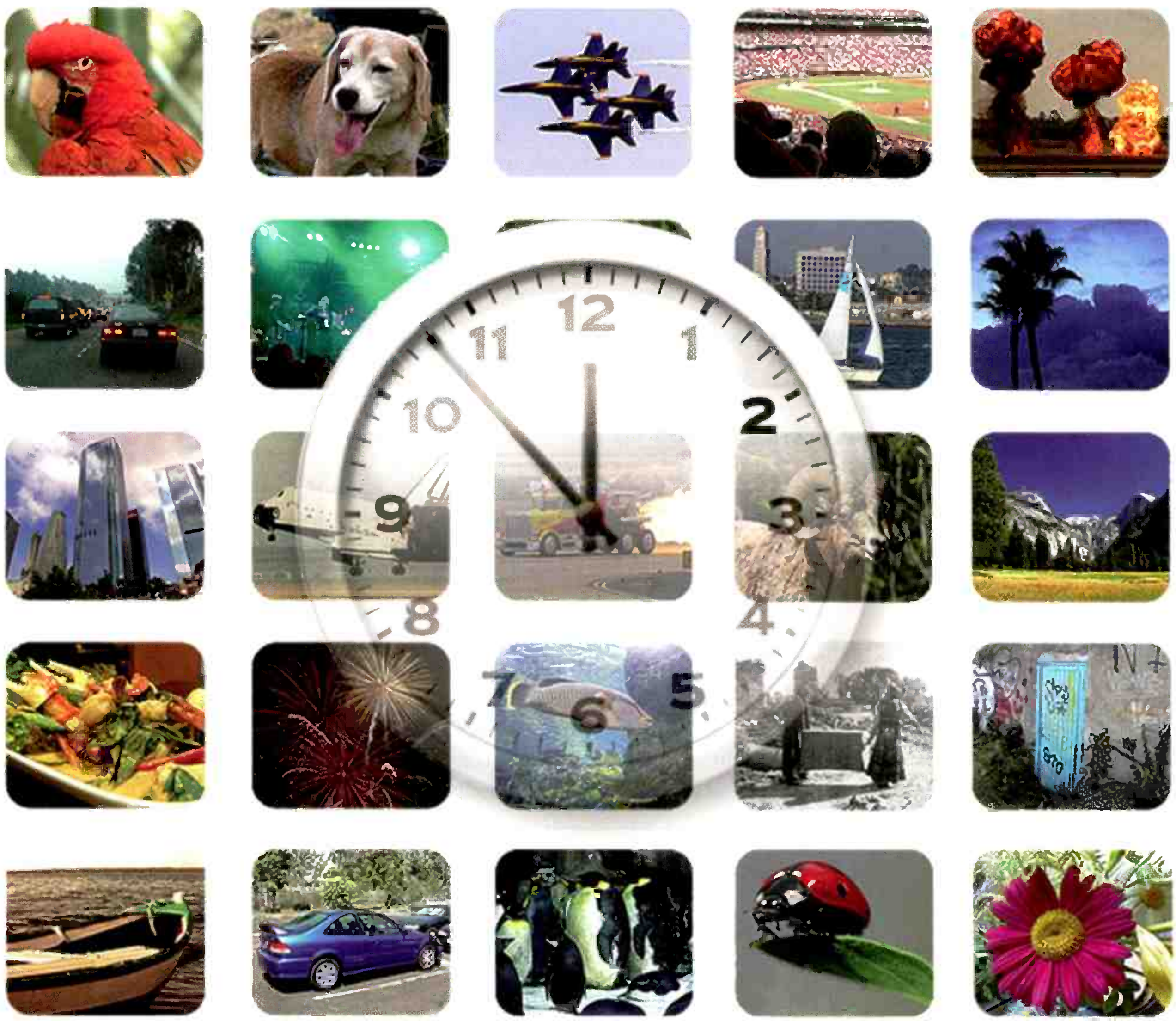
Figure 4. Left-to-right files

The success of these transfer-while-record and play-while-transfer operations relies entirely on the performance of the network between the transmitting and receiving devices. Any bottlenecks on the network will at best result in reduced transfer speeds and at worst result in starved codecs, where the playout device has run out of new frames to play because the network can't deliver them quickly enough.

Conclusion

File-based workflows offer enormous efficiency improvements but require a new set of skills from all stakeholders involved in their design. Broadcasters must be aware of the issues involved in the choices they make as part of their system specifications. Manufacturers must recognize the ever-growing palette of codecs from which to choose and, wherever possible, accommodate additional codec formats as appropriate. System designers must learn new skills and understand the pros and cons of each mainstream codec. As new codecs are brought to market, they must apply intelligence and discretion in helping clients choose the formats for their system. Furthermore, the system designer must understand the implications of transcoding stages in the proposed workflow, and of file format choice on the overall latency of a workflow. File-based workflows represent a major advance in the state of the art for broadcast, but there's still no free lunch. BE

Paul Turner is vice president, broadcast market development, for Omneon.



Achieving high availability for video programming

BY JIM METZLER

Service providers who have deployed next-generation video services on massive IP networks are striving for 99.999 percent reliability to enhance quality, be competitive and increase profitability. They are investing billions of dollars in delivery infrastructure by purchasing complex, advanced equipment such as routers, QAM modulators, ad insertion servers and splicers, multiplexers, passive optical network (PON) gear, and STBs. (See Figure 1.) While this equipment is expected to handle the demanding and unique nature of video content, the unfortunate reality is that manufacturers often don't test it for the stress of a video-centric network.

The performance of these devices is cumulative, i.e., one device's impairments add to the impairments from other devices in the long winding path to the subscriber. (See Figure 2.) With the explosion of digital video, the need for video performance testing has reached a critical stage, and the network equipment manufacturers (NEMs) who provide these devices will need to play a key role.

Service providers have already recognized the need to monitor program availability performance after deployment to ensure their systems are operating as expected. Service providers will also need NEMs to

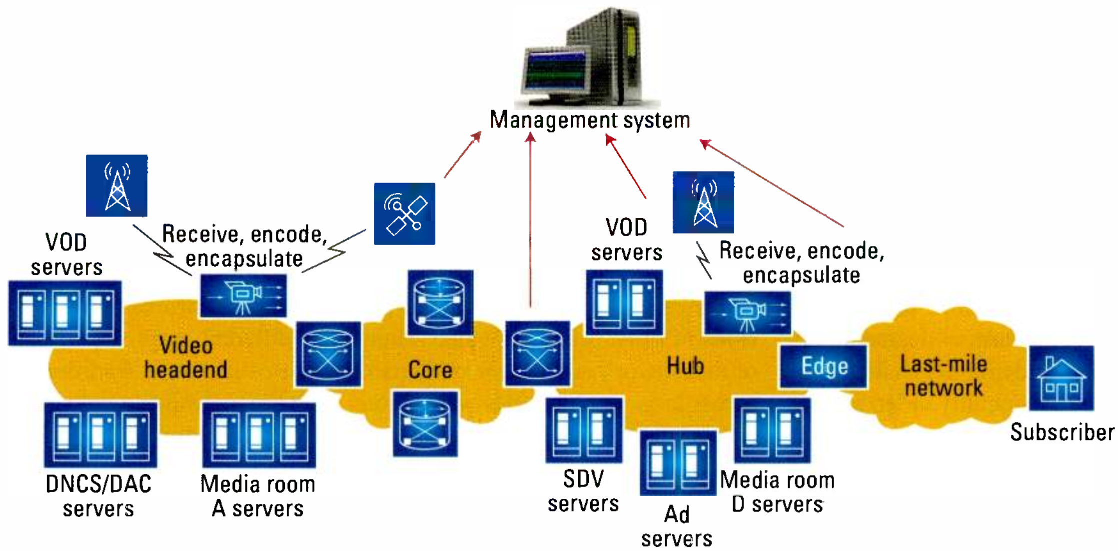


Figure 1. A digital TV network with a routed IP core

provide per video program availability performance reports on all components and systems before deployment to ensure proper component selection and configuration.

This concept, supported by several industry experts, will improve video quality by verifying video component device quality before deployment and lead to increased revenues for all. Without such verification, the current ad-hoc approach to video testing will continue to produce transient operational issues with no accountability and systematic method for improvement.

Recognizing these needs, the SCTE standards organization in the hybrid management sublayer (HMS) subcommittee has been developing specifications and practices for video system monitoring and equipment testing with direction from both service providers and equipment manufacturers based on experience from current deployments.

Measuring the performance of video devices

While there are many metrics that are already gathered during network device testing, video payload availability is often ignored. Some video service providers now use measurements of per-program availability in evaluating the operation of their deployed equipment. They expect their systems will have 99.999 percent availability, which requires that programs be available for all but five minutes in a year. If any single device delivers only 99.000 percent availability, the provider's five-nines goal will be unattainable.

What's needed is a standardized program availability methodology that would give video service providers a way to measure the expected performance of their delivery networks and NEMs a way to measure the reliability of their devices on these networks. This approach would also provide a common language at a crucial point where the two industries meet with a measurement that shows the impact to subscriber experience.

Is program availability an appropriate measurement?

A group of industry experts were asked to comment on this approach. There is widespread agreement that delivering high-quality video services is challenging.

"Video services are critical to Comcast and becoming even more so as additional high definition channels become available," said Charlotte Field, senior vice president, NETO infrastructure and operations, Comcast. Field said that poor video quality tends to frustrate customers, and that frustration is increased if the customer stays home for a half day for a service call that does not resolve the problem.

Stuart Elby, vice president of advanced technology networks, Verizon, pointed out that customers often call to complain about a problem that occurred sometime during the previous few days and that because the problem is not currently occurring, identifying the cause of the problem is "very, very difficult."

Hung Nguyen, the HMS subcommittee chairman at SCTE, highlighted a fundamental challenge associated with delivering high-quality video services. He said that the industry

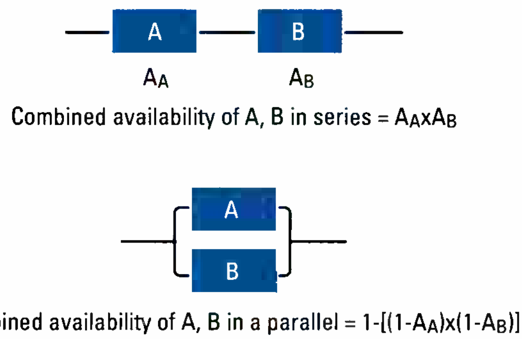


Figure 2. Availability of series and parallel subsystem configurations

has done a good job of delivering relatively high-quality analog video signals. However, he added that delivering a digital video signal is relatively new and is much more complex because it requires so many components, any of which could either fail or could introduce some form of degradation.

Another fundamental challenge in delivering high-quality video services is that the networking equipment deployed to support these services lacks the same, embedded management capabilities and product resiliency that customers are used to having in the traditional telecommunications environment.

"There is nothing built into routers that will give us meaningful management data about the quality of video services," said Jerry Murphy, senior design specialist, TV assurance, Telus Communications. "Troubleshooting video quality based just on use of the command line interface (CLI) of a router is pretty much impossible."

Achieving high availability is a two-part process

First, service providers must enable 24/7 monitoring of each program at multiple locations. Without continuous precision monitoring, they will not be able to measure program availability to five-nines granularity, much less guarantee it. Second, NEMs must test and certify their devices for five-nines availability before they are deployed in these video networks. The devices need to be tested under real-world conditions, over extended periods of time, using real video. Many of the network devices currently used across large deployments were never even tested with real video but are expected to keep pace with years of growth in video loads and evolving SD/HD/MPTS traffic mixes. Consider that even a simple link up and link down (link flap) can drop the program availability of all carried programs to four-nines. The prevailing ad-hoc approach to testing and measurement does not scale to service the needs of the video industry.

Recognizing these needs, the SCTE HMS subcommittee is currently developing specifications for video system monitoring and equipment testing with contributions from both service providers and equipment manufacturers based on experience from current deployments.

What exactly is availability?

Availability/unavailability status is defined in various network standards in different ways depending on the type of network. Traditionally, entering the unavailable state occurs when the performance of a service is highly degraded. Using this definition, if the service is slightly degraded, it is identified as available but with degraded performance. In some standards, the degradation must be completely removed before reentering the available state. Further, the criteria to enter a degraded or unavailable state may require the persistence of a degraded condition for a specified number of seconds. Likewise, the degraded or unavailable state may require the persistence of no degradation for a specified number of seconds, and the durations to enter and leave the impaired

Without continuous precision monitoring, service providers will not be able to measure program availability to five-nines granularity, much less guarantee it.

states may not be equal. An availability definition for general IP networks as described in ITU-T Y.1540 bases availability on a threshold of IP loss ratio (IPLR) performance, for example.

Video service networks are different

As described in various references (TR-126 and HMS draft "Recommended Practice for Monitoring"), even a single lost packet or lost second can cause a user perceptible video and/or audio impairment. An errored second is any second that includes one or more lost program packets. An errored second may also include seconds in which other stream characteristics exceed a preset threshold such as out of order packets, duplicate packets, or unacceptable packet jitter. An errored second may be considered an unacceptable highly degraded condition by a subscriber. With this criteria, a program is considered as entering an unavailable state for any errored seconds. This definition is recommended for many common types of video service networks.

Some quality assurance policies subject subscribers to potentially more severe and frequent impairments because they fail to set a specific, time-elapsed definition of network unavailability. Shorter network programming failures of varying lengths of time — such as tiling, blocking or black screens — are a frequent problem, because most monitoring policies are set up to detect longer failures and outages. These policies are not useful for long-term quality improvement initiatives, because they do not consider the program to be unavailable, and report a different duration of "no program errors."

An errored second might also be defined such that a minimum count of packet loss events (loss period length) must occur before being tallied as an errored second.

In any case, whatever specific definitions and acceptable threshold policies that are adopted by a particular service provider, they should be simple in order to facilitate monitoring and evaluation by operational means.

$$\text{Percent availability} = \left(\frac{\text{[Measured time interval - unavailable time]}}{\text{Measured time interval}}\right) \times 100$$

Figure 3. Availability equation

Calculations and acceptable targets for availability

Availability indicates the number of per-program unimpaired seconds delivered by a device or system under test as a percent of evaluated seconds. (See Figure 3.) For example, for two impaired seconds of HBO (unavailable time) in a one-day period (measured time interval), see Figure 4.

$$\text{HBO\% availability} = \left(\frac{\text{[86400 sec/day - 2 impaired sec]}}{\text{86400 sec/day}}\right) \times 100 = 99.998\%$$

Figure 4. Example of HBO availability

The draft SCTE HMS Recommended Practice for Monitoring document and TR-126 suggest an acceptable per-program performance criteria of one errored second per four hours for HD and one errored second per hour for SD, with an equivalent minimum availability of 99.993 percent (four nines) and 99.972 percent (three nines) per day, respectively.

Different providers may have different performance targets based on

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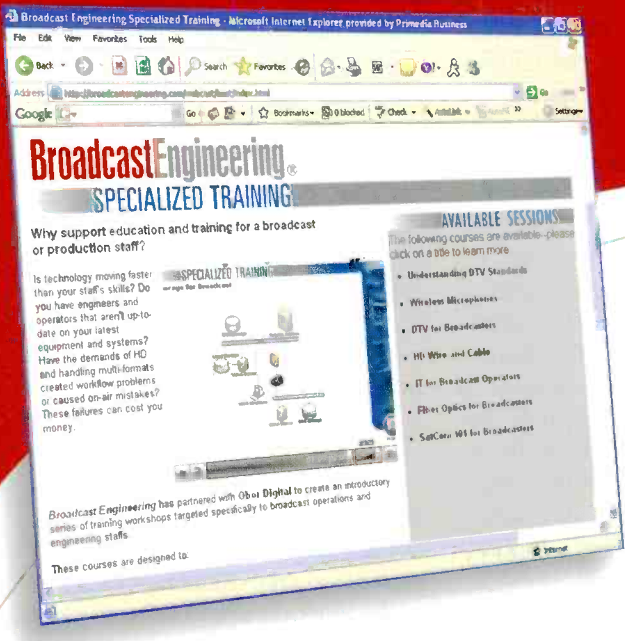

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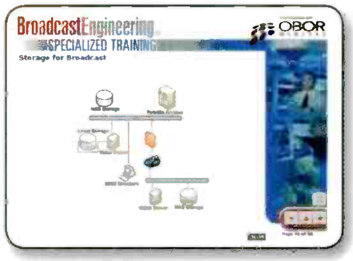

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Some service providers are currently targeting five nines or 99.999 percent availability for their systems. Note that each deployed component must have higher availability than the target availability for the component ensemble. For example, if 10 devices are connected in series and each has 99.999 percent availability, the ensemble would have 0.99999**10 or 99.990 percent availability. Consider too whether the measured availability results of an equipment component will meet deployed system goals.

Availability by network region

While a subscriber may only really care about the availability of programs delivered to the STB, the provider needs to know the program availability at the headend, core and edge distribution locations to effectively direct resources for repair and system improvement. Providers have already deployed monitoring and reporting systems to collect needed real-time information for proactive system fault detection and isolation and data storage for trending. For these systems, availability report generation over time intervals of days or weeks by network region is a straightforward calculation using stored impairment data. Availability by region provides the information critical for effective repair dispatch and prioritizing system upgrades.

Systems without deployed end-to-end monitoring can begin by collecting automated per-channel availability statistics at the edge with a continuous real-time program monitor to represent subscriber experience. This will give the needed visibility to determine what availability the system is currently delivering — the first step needed for implementing a continuous improvement strategy.

Availability reports

Availability reporting is intended to reflect the user acceptability of delivered programs and indicates the availability of "good" program time.

An example report would typically include information shown below, including program name, measurement location if relevant and percent availability. The tested configuration, along with specifications about how the availability is calculated, should also be included. (See Figure 5.)

How to benefit from high-availability measurements

How can service providers achieve high availability (99.999 percent) on video services? The first step is to measure video programs 24/7 at key areas across the live system so per-program statistics can be collected. Next, compartmentalize availability into three key areas:

- Program availability out of the headend or any video origin point;
- Program availability across the wide area distribution system to each hub or drop site; and
- Program availability on the last mile network, post QAM or DSLAM devices.

These key areas allow the service provider to understand how each part of the system is contributing to video service quality. For example, if ESPN is measured for one day (24 hours or 86,400 seconds) and several events occur:

- The headend encoder has three seconds of audio dropouts across the day;
- The core network drops five packets in five separate seconds across the day; and
- The QAM dropped a video PID for two seconds across the day.

The program availability for ESPN

for a customer that day at the end is: PA = ((86,400 – (3+5+2))/86,400) * 100 = 99.988%. Ten seconds of impairment causes the program availability to drop to three nines. The SCTE draft "Recommended Practice for Monitoring" suggests that a program should have no more than six (HD) to 24 (SD) seconds of errors in a 24-hour period. This example would meet that criteria and be OK.

Service providers need to measure for this so they know what the availability of their service is. Many service providers have no idea how good or how bad their systems are. Frequently, OPEX is spent trying to improve system quality with no feedback mechanism as to how good the results are. Without compartmentalizing the measurement, there is no way to know which systems need improvement. Take the ESPN example:

- The headend's program availability is 99.996 percent, and the issue is fixed by looking at audio in the encoder. (The specific fault isolation is key to improving systems, a benefit of simultaneous, live measurement.)
- The core network's program availability is 99.994 percent.
- The QAM's program availability is 99.997 percent.

Clearly, the program availability figure is cumulative; i.e., headend errors add to the errors of the network and both add to the QAM and down to the last mile into the home network and STB availability. (Errors that

	Data Collection Point					
	Core_A	Core_A Egress Hub_1	Core_A Egress Hub_2	Core_B	Core_B Egress Hub_1	Core_B Egress Hub_2
	Measures	Measures	Measures	Measures	Measures	Measures
Program	Availabity	Availabity	Availabity	Availabity	Availabity	Availabity
(A&E (37))	99.442%	99.443%	99.443%	99.443%	99.269%	99.443%
(ABCFMLY (26))	99.453%	99.454%	99.454%	99.454%	99.280%	99.454%
(ACTNMAX (343))	99.443%	99.444%	99.444%	99.444%	99.444%	99.270%
(AMC (59))	99.443%	99.443%	99.444%	99.444%	99.444%	99.444%
(ANIMLPL (63))	98.967%	99.181%	99.181%	99.179%	98.925%	99.179%
(BIOGRPHY (243))	99.442%	99.443%	99.443%	99.443%	99.443%	99.269%

Figure 5. Availability report based on data gathered from video downtime monitors

happen during the same second in multiple systems due to the same cause do not get counted twice.)

Consider another simple example: The link is lost in a single router at a headend servicing 250,000 homes carrying 300 live video programs, and the link return takes the router 25 seconds to return. The program availability for all 300 programs would be 99.971 percent, assuming there are no other errors for the rest of the day.

Delivering high availability begins before program delivery

High-availability capability of all of the components of a live video system is critical to delivering high-availability end-to-end service. Considering how many devices are in a system, how many software updates there are across the year and the number of new services being rolled out, how can a service provider be expected to deliver 99.999 percent availability or any other high availability figures, much less make improvements unless they have accurate measurements?

Service providers are not alone in needing these measurements. Equipment manufacturers, including encoder vendors, VOD vendors and router vendors, need to verify availability to account for the complexity of video. For example, some router manufacturers do not even test with live video at the volumes seen at the service provider. The first time some of these systems ever see thousands of live videos in 10Gb loads is at the service provider after being deployed. Manufacturers of such equipment components must be sure their test beds in QA test labs, engineering labs, manufacture and test labs include data and voice test loads, as well as live video in realistic volume. Also they must ensure it is measured in the same way service providers will do in monitoring deployed systems. They can also produce program availability reports as part of the hand off of equipment and software from the

High-availability capability of all the components of a live video system is critical to delivering high-availability end-to-end service.

OEM to the service provider. If the equipment manufacturer can only achieve two nines (99.000 percent) or three nines (99.900 percent) under long-term, normal operation with configurations that mimic service provider networks, then the service provider will at least know that this is the best they can do with the system being deployed. They will also know what is causing the loss in availability so they can predetermine how to handle issues before customers call in with quality complaints, causing soaring OPEX. Or, given the test results, the provider may simply choose to deploy a device better suited for video service delivery.

If availability tests are completed in a lab environment, the results may be better than a field-deployed system subject to more unpredictable sources, physical interconnect stresses, environmental condition stresses such as temperature and humidity, power line transients, and human errors. This may cause the acceptable criteria as measured in these tests to be set somewhat higher than might otherwise be considered.

Of course, other tests should also be executed to complement these baseline tests before final equipment selection and deployment. Such tests would typically include, but are not limited to, the intended load levels; number, type, and speed of active ports; level and type of nonvideo converged traffic expected; forwarding protocols; and management protocols, as well as common voice and data tests that are expected in the operational environment.

Conclusion

Service providers are deploying continuous, real-time per-program quality assurance solutions for their IP distribution systems, which created the need for video device vendors to upgrade their testing suites. Delivering high-availability systems that handle the unique requirements of video payloads depends on each component of the system being up to the task but, in many cases, today's components have not been verified as being able to deliver the high availability needed, which dooms providers' goals before they get started. Testing new equipment for program availability with real video loads and with common operational impairments is needed by service providers who are under increasing competitive pressures to improve quality. Designing and deploying a high-availability delivery system begins with the selection of components that have a tested and proven high availability. BE

Jim Metzler is an independent telecom consultant for Metzler and Associates.

IBRIX's Fusion

The file serving system increases throughput performance and scalability at Scripps Networks.

BY CHUCK HURST

Scripps Networks is a media company that covers home, food and lifestyle. Its brands include HGTV, Food Network, DIY Network, the Fine Living Network and Great American Country (GAC), as well as Scripps Networks Digital, which is comprised of more than a dozen lifestyle Web sites.

The company recently implemented IBRIX Fusion, a software-based file serving system for scale-out network-attached storage, to help store, manage and process graphics, video and still imagery in multiple file formats of varying sizes. (See Figure 1.)

Assessing storage architectures

Traditional NAS, where the server and storage are coupled together into an appliance, not only is prone to bottlenecks at very high I/O rates, but also is difficult to manage as more appliances are added. Scale-out NAS differs from traditional NAS by allowing data access to be delivered through as many file servers as needed to achieve the required aggregate performance and capacity scaling.

Because Scripps Networks' storage requirements are expected to grow to petabyte levels, having a scale-out NAS infrastructure as a cornerstone of its media asset management initiative will allow the company to address new market opportunities more quickly.

In assessing solutions, Scripps Networks' near-term requirements were simple. It needed an architecture that could support growing storage volumes without sacrificing performance. But it had a longer shopping list that included:

- multivendor storage support;
- intelligence;
- manageability; and
- support for varied file sizes and types.

The solution

The IBRIX file serving software is installed on Sun Fire 4200 servers, while management software resides on a Sun Fire 4100 system. These dual core/dual CPU systems use the Opteron 64-bit processor and run the Red Hat operating system. Scripps Networks also runs native clients on Linux and Windows boxes for greater throughput and connectivity.

The company uses 3PAR's S400 product with approximately 100TB of formatted storage. Within the SAN, it uses Brocade 5000 switches connected at 4Gb/s. Outside of the SAN, the company has built out a 10GB network backbone for its house LAN. Scripps is in the process of shifting its media processing applications, such as transcoding, to sit directly on the 10GB backbone and connect to the scalable file serving solution at high speed. With an increasing number of SD and HD files, the company needs all the speed it can get.

The chosen solution is software-based and hardware-agnostic. Scripps Networks can pair it with any combination of servers and storage. Typically the solution is installed on one

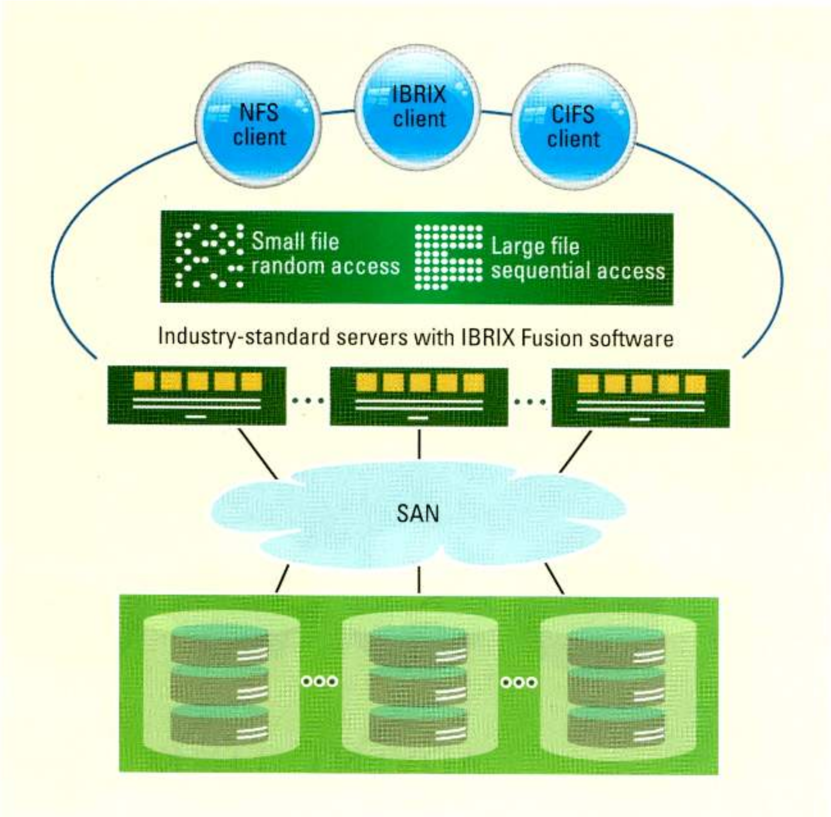


Figure 1. IBRIX Fusion software installed on industry-standard servers provides scale-out network attached storage for processing graphics, video and still imagery in multiple file formats of varying sizes.

node in a cluster of servers, where it pulls together the file systems and storage capacity of each server into a single namespace or centrally-managed pool.

For extra performance, the solution can be installed on additional nodes, which share the I/O and workload balance tasks.

For extra performance, the solution can be installed on additional nodes, which share the I/O and workload balance tasks, and online capacity additions are quick and transparent. Plus, the media company can independently scale for bandwidth or storage capacity simply by adding more servers to increase performance or more disks to increase storage volume.

Application access to the scale-out NAS is closely tied to the service-oriented architecture. The company has created a single namespace for its video, still images, graphics and production-related content, and it controls file access via Web services that implement business processes. For instance, ingest, search and distribution all access scalable file serving as part of the workflow.

Results

Scripps Networks hasn't yet measured scale-out NAS in terms of strict ROI, but it has measured the extent to which the system supports the needs of its media asset management initiative. Scalable file serving has met these needs — particularly speed and scalability. Other ROI indicators to date include:

- the elimination of point solutions;
- reduced maintenance;
- a vendor-neutral environment; and
- a highly available, centralized archive for all enterprise content.

In addition, to save costs, the company is moving to hierarchical storage management using data tiering. Data tiering works by setting guidelines and automatically moving infrequently accessed data to slower, cost-effective storage while storing only high-demand data on faster, higher performing storage. This capability supports the company's ongoing effort to optimize storage resources and improve overall storage efficiency. It also enables higher bit rates for both standard and HD content. **BE**

Chuck Hurst is vice president of systems development at Scripps Networks.

Monitoring video

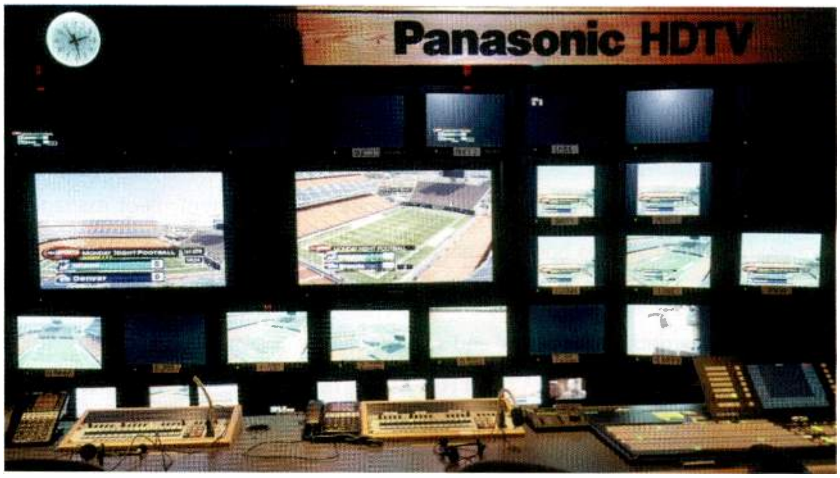
New capabilities add increased complexity to today's multi-image displays.

BY JOHN LUFF

It's not hard to monitor video. What could be simpler? Plug a BNC video cable and RCA audio cable into a monitor, and — glory be — it works! There was a time when it was that easy, in the era when you could predict with concrete certainty that video came in two flavors: NTSC and PAL, with an occasional dash of SECAM, and audio was analog. Steadily over the last 30 years, the world of analog certainty has become the fuzzy world of digital confusion.

First, video became analog components (several flavors subtlety different), and then the signals became digital. In 1978, we saw HDTV for the first time in North America at a SMPTE conference at the St. Francis Hotel in San Francisco. Francis Ford Coppola was there looking at the NHK research development, and I peered over his shoulder at what would become the future of this industry and a major force in my career. At the time, it was made up of analog components, but we figured out how to first digitize and then compress the content to smaller pipelines.

The point is that the proliferation of signal formats and carriers (digital and analog) has steadily made monitoring content more complicated. Oh, and don't forget the interconnection and scanning standards developed for the computing industry. That certainly does not make it any easier, with VGA, SVGA, XGA and a host of alphabet soup connection standards. If you really want to be confused, add compressed formats, which conveniently, or inconveniently, often use the same BNC for interconnection.



In 1999, the first all-flat-panel monitor wall featured multiple Panasonic 16in LCD monitors and was used for ABC's "Monday Night Football" broadcasts.

Scaling content to the screen

As the industry has strayed further from the simplicity of analog on BNC, it has the good fortune that hardware and software had to be developed to enable both professional video industry hardware as well as CE solutions to monitor multiple scanning standards. For the first couple of decades while the modern desktop computer industry was changing, the format on-screen was a matter of scanning the beam faster or slower and adjusting deflection hardware to get the geometry to work out. When displays became digital, a new product was needed (a video scaler), which could fit the content to the screen instead of the screen to the content. Though a simple concept, this has a profound impact on monitoring today.

Some monitors had scalers built-in by the late 1980s, allowing any single signal to be adapted to the technology of the display. About a decade ago, products emerged that took multiple signals and scaled them each to fit in a window on the screen. The first such device I saw, perhaps 20 years ago, was designed and manufactured in Europe, and I remember the price was astronomical and the quality degraded. But monitors above 20in were called projectors then.

By about the middle of the last decade, systems leveraged the availability of scalers designed largely for CE applications to allow flexible windows to be mapped onto a single output, and at higher total resolution than that most common for the day. Feeding the output of such a processor to a flat-panel display, plasma and later LCD permitted content to be displayed at *nearly* the same apparent resolution as a small monitor in the ubiquitous monitor wall, which was often a 9in diagonal screen.

Resolution enhancements

Think about the resolution for a moment. Using the 525 signal rule of thumb, optimum viewing distance for a 9in monitor is 6X the picture height, or about 43in. If you're any closer, you see scan lines, and any farther away, you miss some of the potential screen resolution. On a 42in monitor, you can get about five virtual screens of this size across the display. Using rack-mounted monitors, you would get no more than four. Using multi-image processing, more monitors can be displayed in the same surface area.

Let's not confuse the displayed resolution, however, because to fully display the native resolution of a 720 x 480 picture for each virtual 9in monitor would require a display approaching 4K resolution. The key is that unless you are about 30in away from 42in, or less, you don't perceive the loss of real resolution, assuming perfect image scaling.

This convenient fact allows us to sit back at a comfortable viewing distance and see good approximations of what a wall of CRT monitors would show; it has revolutionized monitoring. I built the first all-flat-panel monitor wall, with multiple 16in LCD monitors that had essentially the same resolution as 720p HD signals, for an ABC "Monday Night Football" production truck in 1999. It was a technical success, meaning the goal of reduced weight and power consumption compared with CRT options was achieved. It would be silly to do that today because about 10 to 12 flat screens would have allowed the same results with infinitely more flexibility and less wasted space between monitors. And maybe my hair would be less gray as well.

The importance of multiple inputs

From the view of a system designer, it is important to build systems that allow multiple inputs to be mapped to more than one output, with internal routing of signals to allow duplication of inputs. Using the ability to scale images to arbitrary virtual monitor sizes creates flexible composite displays that provide tremendous monitor wall layout options to production professionals. Systems can offer internally generated clocks, map external tallies to the virtual monitors, display audio from discreet and embedded sources, accept HD and SD sources from multiple standards, decode ratings and closed captions, and accept background images to fill the screen. These capabilities make a virtual monitor wall much more powerful than the CRT approaches, which were the sole option a few years ago.

It doesn't stop there; many of these capabilities are starting to show up in stadium-size display processors. Don't be surprised if the largely static mapping of inputs onto an output plane becomes dynamic over time to allow complex productions to be created in part by manipulating the canvass that a complicated multi-image processor addresses. **BE**

John Luff is a broadcast technology consultant.

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

Autoscript — Mango

Foot control that connects directly with WinPlus prompter software, offering built-in intelligence to allow production staff or multiple presenters to allocate any controller for use at any time and with failsafe accuracy; using intuitive deskpad keys, the presenter can immediately assign specific controllers, view which ones are live, personalize them, and enable or disable.

203-338-8356; www.autoscript.tv

Cisco — Digital Media Manager

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800-553-6387; www.cisco.com

Elber — WLCT-02SD

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+39 0185 351333; www.elber.it

DK-Technologies — PT0710M

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800-421-0888
www.dk-technologies.com

Grass Valley — MEDIAEDGE4

Content delivery platform can decode H.264 content as well as MPEG-2 content from existing MEDIAEDGE3 systems; includes a new HDMI output connector to enable the use of a wider variety of HD monitors and displays; allows users to store and deliver HD content at about a 30 percent lower data rate than MPEG-2; existing MEDIAEDGE3 users can upgrade for a small fee.

201-818-4050; www.grassvalley.com

Neutrik — XX-HD series

XLR cable connectors equipped with a heavy-duty, hybrid metal/rubber design to protect against dust and water; meet IP67 rating requirements; series includes a three-pole female XLR connector with optional black housing and a three-pole male XLR connector with optional black housing; include rugged zinc die-cast shell and gold contacts; offer chuck-type strain relief system for secure cable clamping.

732-901-9488; www.neutrik.com

Axon Digital Design — HDK100

HD/SD downstream keyer designed for the Synapse system; features four HD/SD inputs (two background inputs, one fill input and one key input) and four HD/SD outputs (two program outputs, one preview output and a user-definable output); controllable via Ethernet or GPI; compatible with SD-SDI and HD-SDI; can be upgraded to 3Gb/s compatibility; includes transparency for 16 channels of embedded audio and all ANC data.

301-854-6557; www.axon.tv

Blackmagic Design — UltraScope

3Gb/s SDI and optical fiber SDI scope designed for editors and colorists; plugs into any compatible Windows computer with a 24in monitor; displays six live scope views simultaneously; auto detects SD, HD and 3Gb/s SDI inputs.

408-954-0500
www.blackmagic-design.com

TANDBERG — WatchPoint

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678-812-6300; www.tandbergtv.com

Utah Scientific — UCP-MV

Visual control panel demonstrates new approach to user interface design for routing switchers; panel uses two touchscreen LCD monitors to combine monitoring and control functions on a flexible 3RU panel.

801-575-8801
www.utahscientific.com

ESE — DV-319

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310-322-2136; www.ese-web.com

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631-845-2000; www.chyron.com

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Success story

Dear editor:

I have been reading *Broadcast Engineering* for the past three years and never really had hands-on experience in the field. About a month and a half ago, I started an internship at a production facility in Los Angeles and was put to work doing signal processing/engineering.

The first project I was given (after only 30 minutes on the job) was to redesign the video patch system the facility was using. To complicate things, I had been brought on as a visual artist — not a technician. But my job was to integrate SDI HD/SD and standard NTSC equipment with multiple SD and HD decks, a rack of signal processing cards and TC generators. I had never actually touched a patch board, let alone any of the high-end equipment we are working with before that day. However, due to the theory and articles in your magazine, I was able to navigate quite well with only a few minor hiccups.

After the job was finished and everything was working, I was asked how I knew how to do that kind of work. I was able to say I knew how to do it based on what I read in your periodical. Thanks!

Louis Silverstein

Analog died while I was running

Dear editor:

In response to your "Analog died while I was running" post on your *Brad on Broadcast* blog, I understand your grieving about the loss of analog broadcasts. I have a small analog LCD TV. It's portable, got great reception and ran for four to five hours on four AA batteries. It was a great TV for emergencies.

Unfortunately, I've found that there are no good replacements for this TV. There are a few "off" brands offering portable digital TVs. However, they have much larger screens than I need, much shorter battery life, nonuser replaceable batteries, and are virtually worthless without external antennas.

I purchased a battery-powered weather radio at the beginning of the year in preparation for losing my little TV, and I forgot about the TV band issue. So I also now have a brand-new emergency radio that is missing this handy feature. Luckily, it has a NOAA weather band setting on it.

I'm sure that the digital signal will work fine for many people. I will be the first to admit that the picture does look quite good without any "snow," but there are many aspects of analog that will be sorely missed. For instance, I'm out in the country, 30mi away from the local transmitters, and I have completely lost our local ABC and CBS stations since the switch. With analog, we sacrificed a little bit of picture quality for a reliable signal, but with digital, we sacrifice reliability for a great picture. In my opinion, this is a step backwards. My satellite signal goes out when it drizzles, so I always end up relying on the over-the-air signal during foul weather. If a tornado is on its way, I would much rather have a reliable signal and a slightly grainy picture than no picture at all with the potential for a perfect picture.

I imagine that many years down the road, the sensitivity of ATSC (digital) tuners will improve, and this type of situation will not be as problematic. Until then, I guess we must accept the "downgrade," buy larger antennas, and put a few of our beloved gadgets on the shelf for good.

Zeb Albert

Post-DTV transition

Dear editor:

Someone should do a follow-up or survey on what the DTV conversion left us with. Many in the Puget Sound region lost most of their channels due to weak signal transmission. Technicians willing to measure for a better antenna location are expensive, and are trying to push satellite or cable TV instead. I have a fringe antenna and two preamps. I only get KBTC-TV and FOX now and then. I lost all the Seattle stations.

This will also hurt the TV stations and their marketing money. Will they be allowed to increase power or set up satellite transmitters? Or are we all being forced by the government to convert to cable or satellite TV?

Personally, I'm going to try to get away from TV more, go to the gym to fill my time and rent Netflix. I do miss some favorite shows from NBC and ABC though, and winter will be a real drag. I won't get storm and emergency alerts either.

What are the TV stations saying? The FCC? I've read online many similar stories everywhere, especially the East Coast.

Doug Compau

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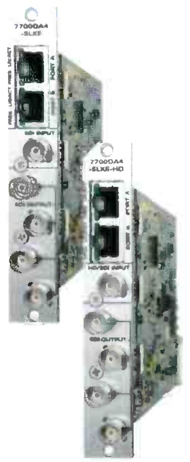

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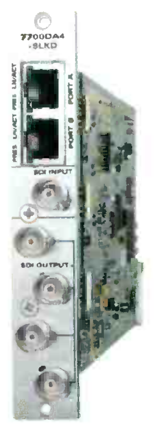

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- Accepts IGMP (Multicast) and Unicast IP delivery
- On-board signal monitoring and diagnostics
- High density approach offers 15 decoders within 3RU
- Portable or rack mounted frame assemblies
- VistaLINK® -capable

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