AUGUST 2006

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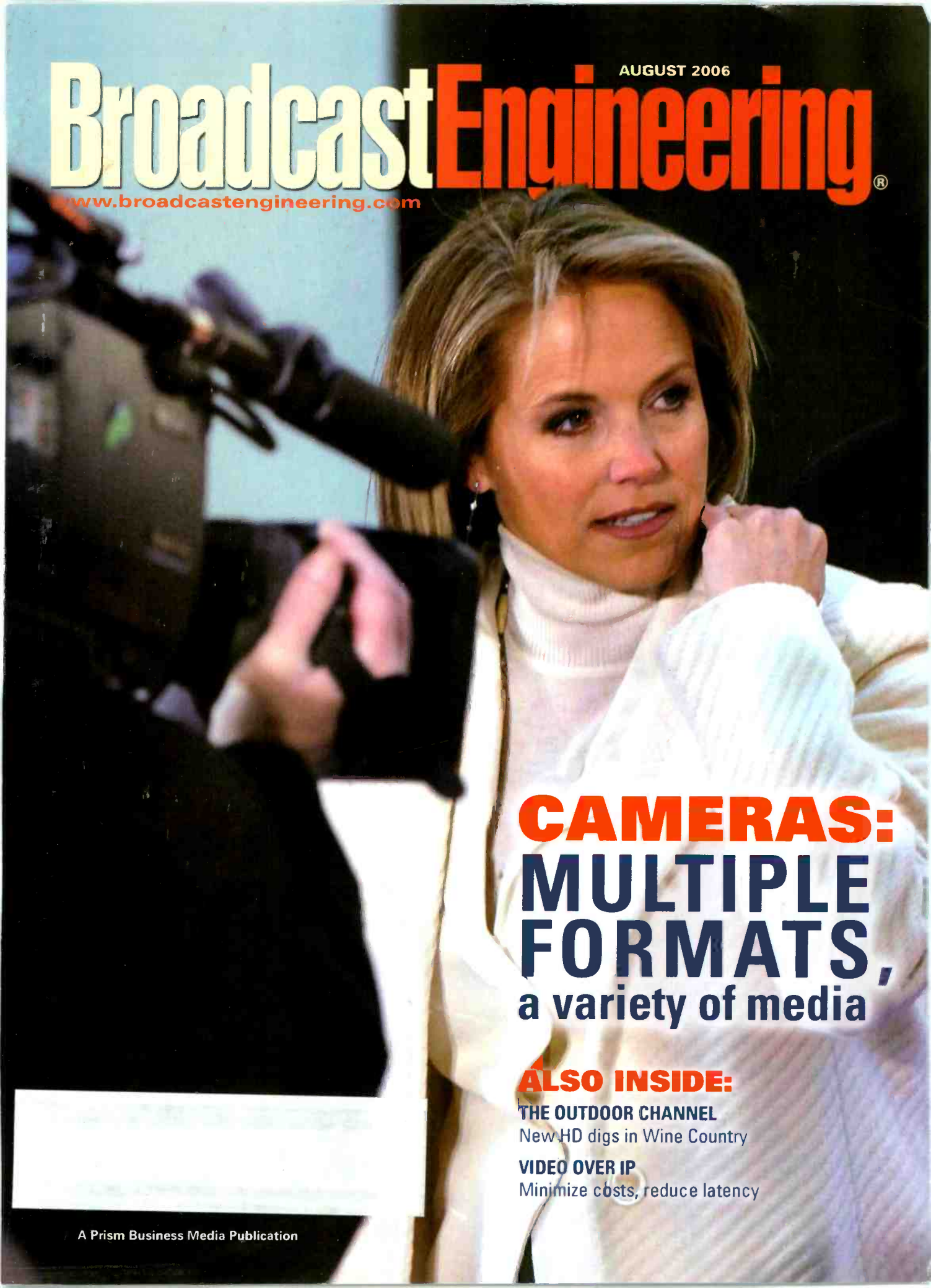

CAMERAS: MULTIPLE FORMATS, a variety of media

ALSO INSIDE:

THE OUTDOOR CHANNEL
New HD digs in Wine Country

VIDEO OVER IP
Minimize costs, reduce latency

A Prism Business Media Publication

D-12: Compact Enough for OB
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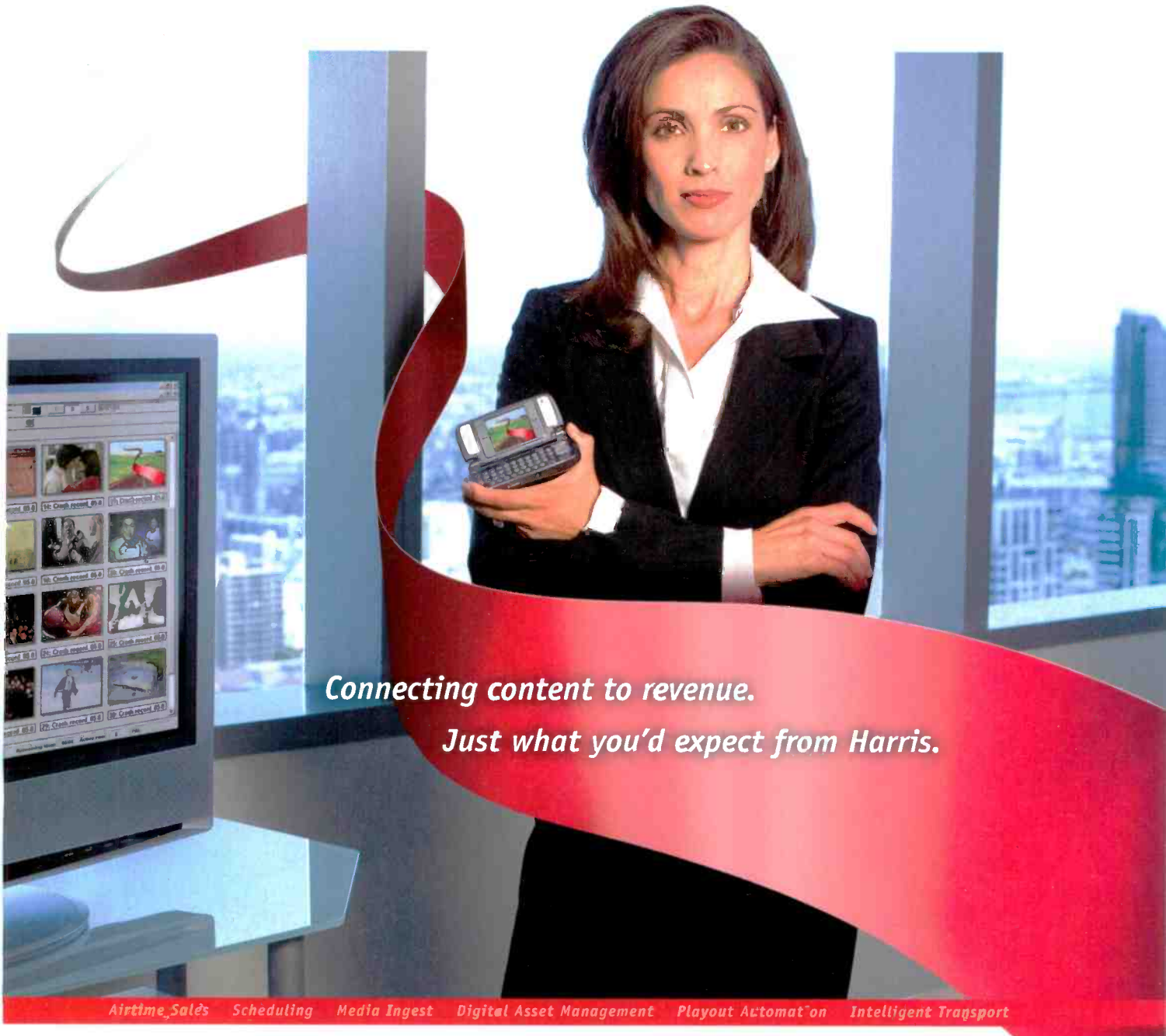

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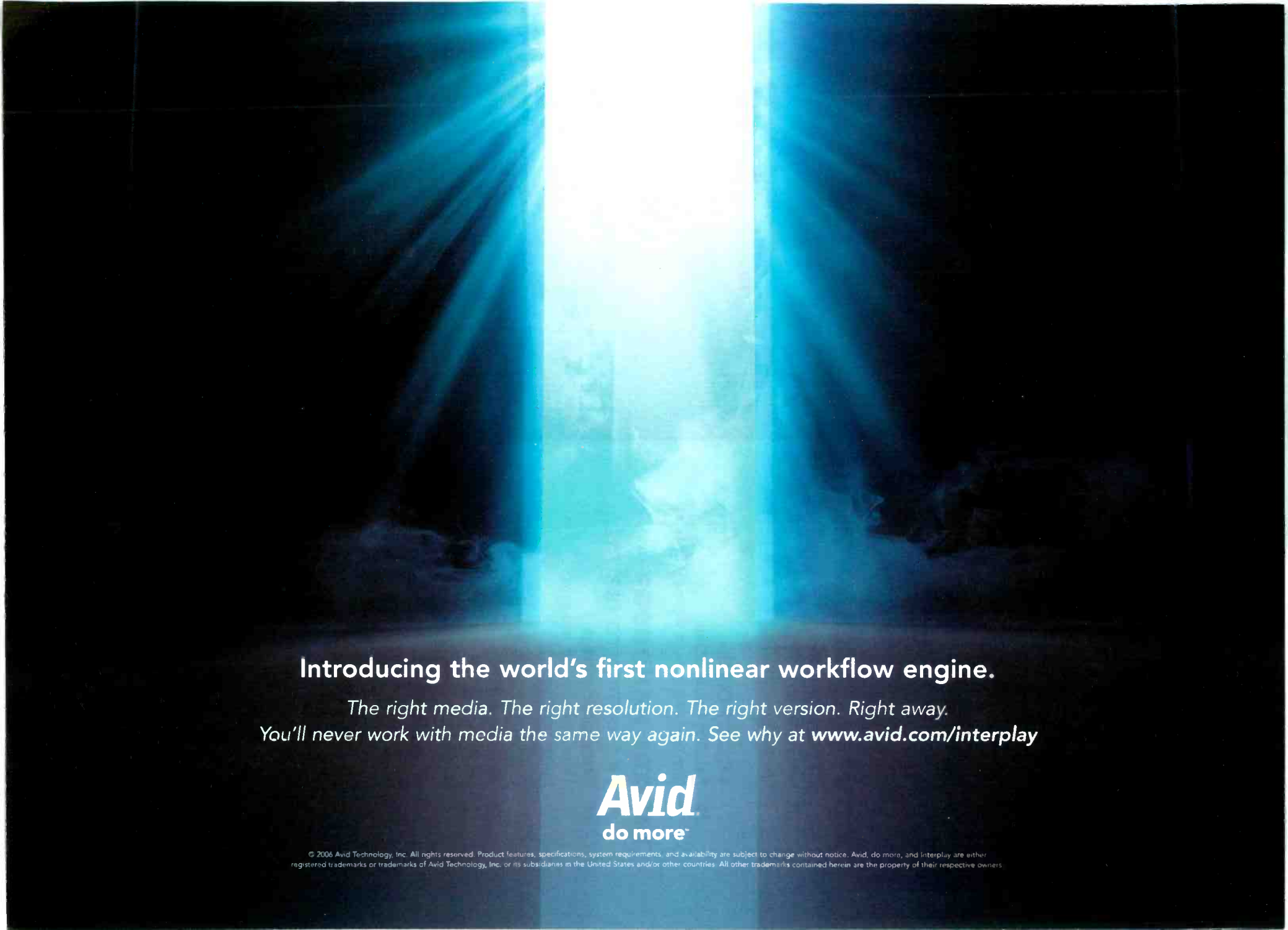
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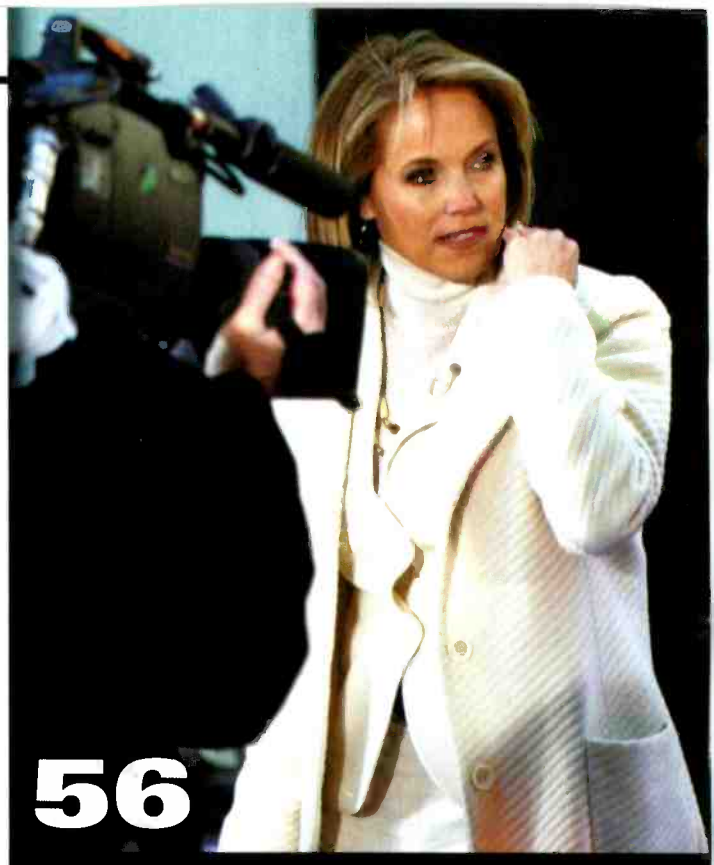

ON THE COVER:
News is now shot for TV, Internet and cell phones. This demands a camera that is easy to integrate into the production workflow. Photo courtesy AP Images.

AUGUST FREEZEFRAME QUESTION

What is the official analog cut-off date?

Readers submitting winning entries will be entered into a drawing for *Broadcast Engineering* T-shirts. Enter by e-mail. Title your entry "Freezeframe-August" in the subject field and send it to: editor@prismb2b.com. Correct answers received by Nov. 1, 2006, are eligible to win.

Amazing color reproduction - Broadcast-quality gradation, split-screen freeze-frame for scene comparison, color space conversion and different color temperature settings are a few of the ways Panasonic HD monitors let you achieve true color matching.

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NEW PRODUCTS

DEPARTMENTS

APRIL'S FREEZEFRAME ANSWER

Q. Consider an RGB signal, representing red, green and blue. It requires ____ channels for transport; ___ percent represents pure black and ___ percent represents pure white.

A. Three channels for transport, 0 percent represents black and 100 percent represents white.

APRIL WINNERS:
Tim Costley, John Harris, Al Van Dinteren

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Perky news

It's said that packaging is everything. You can sell smelly socks if they come wrapped in an attractive box. After viewing the recent debacles on the network news channels, packaging seems to take precedent over content.

Television news was originally presented in black and white with a male newscaster and facts, sometimes accompanied with a few films. Frankly, it was pretty boring. Fortunately, we're past those constraints.

But it seems that television news has shifted from "here's the news" to "here's the package, which contains the news." It's more about package and presentation than about content. Call it happy-talk news wrapped in a pretty package.

Put a beautiful newsreader personality — often not even a trained journalist — in front of the camera and have him or her read what someone else has written. In

my television days, newscasters wrote much, if not all, of their copy. Today's newsreaders would be totally lost without the teleprompter telling them what to say.

OK, maybe it is time for change. And that's exactly what CBS has in mind. Unless you've been sleeping under a rock, you couldn't have missed that television mega personality Katie Couric will take over newscasting duties from longtime newsman (and rating increaser) Bob Schieffer next month.

In September, she steps into the huge shoes of venerable CBS news anchors Edward R. Morrow, Walter Cronkite and Dan Rather. The network is quick to highlight, "Couric will become the first female solo anchor of a weekday network evening news broadcast."

CBS is reportedly spending more than $15 million per year to buy the most recognizable face on television to take over from the old guard. Never mind that her own CBS bio lists only six years as a television "reporter."

The network must not be totally convinced the pretty package will be enough, because it launched Couric on a cross-country "listening tour." The last time we heard that phrase was when former First Lady Hillary Rodham Clinton was trying to convince New Yorkers she was a resident of a state she'd never lived in before. That said, she is now Senator Rodham Clinton.

Can you imagine Walter Cronkite on a listening tour to learn what viewers wanted to see on TV news? Doesn't news work the other way around?

Can you imagine Walter Cronkite on a listening tour to learn what viewers wanted to see on TV news? Doesn't news work the other way around? News happens, and reporters and newscasters report it.

The CBS press office said the listening tour was designed so Couric could meet with viewers informally. One hundred people from each of the six communities she visited were invited to the closed confabs.

However, rather than being open meetings, the events were carefully staged to prevent the news media from attending. In Minneapolis, WCCO-TV staffer Matt Bartel was initially denied permission to attend because he runs a local Minneapolis blog. The writer was finally allowed inside, but only after he "surrendered his pen."

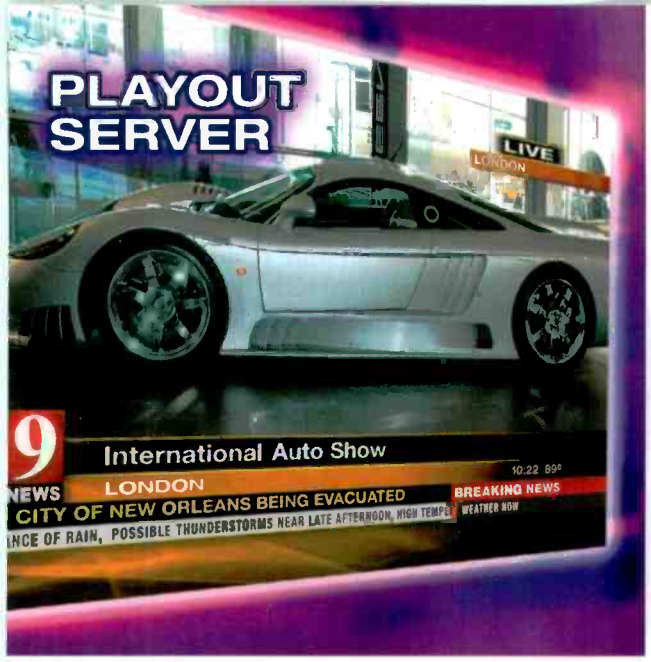
With this as backdrop, you still have to give CBS credit for trying something new. It's willing to give a popular personality a clean shot at its most prestigious news program. Will viewers (and advertisers) warm to a perky $15 million face delivering today's disaster headlines? Maybe so. After all, packaging seems to be everything. **BE**

Readers will notice the new design and presentation of Broadcast Engineering *magazine. The staff has worked hard to bring you a fresh, colorful, easy-to-read — yet always in-depth — coverage of this industry. And, it didn't cost $15 million. Let us know what you think at editor@prismb2b.com.*

Brad Dick

EDITORIAL DIRECTOR

Send comments to: editor@prismb2b.com



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FOR THE CHANGING FACE OF TELEVISION

Going green

Editor:

Contrary to your unpopular disbelief, consumers can and do make informed, environmentally conscious decisions every day. Your analogy: "that's like saying people buy cars based on how long they can go between oil changes," in the June editorial is completely stupid. Of course people don't make decisions based upon oil changes, but they do make car-buying decisions based upon fuel efficiency, evidenced by the rise in the popularity of hybrid and E85 autos, and people dumping their gas-hogging SUVs for more fuel-efficient models. I would even speculate the last time the Dick household purchased a vehicle, fuel economy was at the forefront of the buying decision.

So what is so wrong with labeling more consumer devices with energy efficiency information? Refrigerator, freezer, washer and dryer, and other appliance manufacturers have published this information for years, and consumers *do* pay attention and make decisions based on this information.

You have my permission to print this in your magazine, although it's doubtful it will make it out of your recycling bin … you do recycle?

Lee McKenna

Audio peaks

Editor:

I work for a TV and film production facility. We master on Panasonic DVCPRO HD and Sony Digital Betacam. Recently, clients have demanded louder levels, and our audio levels have been creeping up. I used to keep the peaks on the Digital Betacam meters at no more than -10dB (the reference tone being at -20dB). I thought this was some kind of standard. Now we are way up there, peaking at -4dB and compressing so as not to go over -4dB. It's pretty squashed.

Can you point me to any guidelines so I can explain why this is too much?

Joe Renna

Robert Fritts, audio mixer, Henninger Digital Audio, responds:

I'm not going to say that audio peaks above -10dBFS are a standard among all broadcast facilities, but it is a common practice throughout many broadcasters. Transient audio peaks must not exceed +10dB above reference tone when measured on an audio peak meter with the ballistics set to 0ms rise, 200ms fall. The NTSC reference tone should be set to -20dBFS. The problem with transient audio peaks reaching such high levels is that they may be clipped by the transmission limiters in the broadcasting facility.

For years, mixers have used the VU scale to give an indication of the average audio level, but this method of measurement does not accurately show the true transient audio peaks. So the true peak audio meter is used to measure and ensure the mixers that their audio peaks fit into the allotted space for transmission.

Every mixer has been in a situation where the producer asks for the mix to be louder. This is when the mixer needs to apply the right amount of compression and limiting to control such high levels. It is also important to keep a good sense of dynamic range for a good sounding mix.

A new method of audio measurement — called dial norm — is finding its way into mix rooms and broadcast facilities. Dial norm measures dialogue (human speech) and its overall volume over an entire program's length. Dolby developed such a product called the LM100. The device uses an algorithm to isolate human speech, measuring its volume over time and producing a dialogue level for a program.

The LM100 provides a true measurement of the overall loudness, but it does not determine whether a mix is good or even-balanced. VU and peak metering methods, along with the LM100, can give the mixer a better representation of the overall mix and how it best can fit into a safe range for broadcast transmission.

These tools are useful, but in the end, it's the critical listening of one's ear that determines the validity of a mix. BE

Test Your Knowledge!

See the Freezeframe question of the month on page 6 and enter to win a *Broadcast Engineering* T-shirt.

Send answers to editor@prismb2b.com

A Guide for Broadcasters To No-Compromise, File-based Server/Storage Systems

As the acceptance accelerates for IT-based technologies such as video servers, nonlinear editing systems, centralized storage, and more, broadcasters and video professionals must have options that give them the confidence to commit to moving wholesale to approaches that avoid many obstacles that today block their ability to truly improve their workflows.

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HD's killer app?

Sports are driving HDTV adoption.

BY CRAIG BIRKMAIER

The era of HDTV broadcasting in the United States began near the end of 1998. Nearly a decade later, many industry pundits are still looking for the killer app that will drive consumers to replace their old analog TVs, hopefully by the time NTSC broadcasts are scheduled to end in 2009.

There are nearly as many opinions about what will motivate consumers to take the HDTV plunge as there are TV programs offered in HD during the past eight years. In 2004, a *Broadcast Engineering* e-newsletter reported the results of a research study conducted by Lyra Research, "Desperately Seeking Content: A Survey of HDTV Users." The study, which polled 500 existing HDTV viewers, found that movies were considered to be the most important form of HD content, followed closely by sports.

Somebody throw the switch

HDTV has evolved from very humble beginnings, starting with the Japanese 1125/60 HDTV system and the Eureka HDTV Project during the '80s. At NAB in 1989, I saw the fruit of the Eureka project. From 30ft away, the picture looked washed out and lifeless, so I took a closer look at what was *wrong*.

The HD monitor was playing back a European "football" match. The program was captured with a 1250/50 HD prototype camera and was being presented on a 30in studio monitor. It didn't look much better up close, though one could see that there was more detail than in the standard-definition displays that filled the NAB exhibits. The images were good, but lacked contrast. The display was too small to render the available detail in a manner that viewers would find compelling.

Some industry pundits went so far as to claim that primary purpose of the Eureka HDTV Project was to derail HDTV in order to prevent the Japanese 1125/60 HDTV system from gaining a foothold in Europe.

It is noteworthy that HDTV is finally gaining favor in Europe ... again. HDTV broadcasts of the recent World Cup met with a positive response in Europe and around the world.

During the advanced television standards setting process in the United States, I witnessed many demonstrations of HDTV. They were usually paired with the worst possible NTSC images one could conjure up — nasty ghosts from multipath and enough snow to go skiing.

Demonstrations of HDTV ... were usually paired with the worst possible NTSC images ... nasty ghosts from multipath and enough snow to go skiing.

Over the years, the quality of HDTV improved. However, it still wasn't enough to convince me to start paying for HD content.

We purchased our second HD-capable display just before Christmas in 2004. It was a 16:9 52in DLP-based rear-projection unit. I borrowed an HD cable box from a friend to see firsthand what I was missing. Not much. We never saw a program in HD on our old set, and it didn't look like we were going to on our new one either.

There were only seven HD channels, and much of what they carried was upconverted standard-definition programming. By the summer of 2005, however, the situation started to improve. ESPN HD had begun operations, and the local cable system began carriage of the NBC and CBS stations that serve the Gainesville market.

By the next Christmas, I was ready to take the plunge, motivated in large part by the number of college bowl games that ESPN HD promised to carry. The Scientific Atlanta HD-PVR was ready for the bowl games in HD, and we were ready for some football!

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

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Source: NAB

www.nab.org

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— **Sean Richardson**, Manager
Audio Post Production
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The feature game of the evening came on — in standard definition with the ESPN HD pillar boxes announcing to the world that this was *not* HD. Then someone remembered to switch the network feed to the HD broadcast. As Emeril Lagasse would say, "BAM!" Talk about kicking it up a notch! Sports *is* the killer app for HDTV.

Resolution realities

Somewhere out there a bunch of marketing and PR types are scratching their heads, trying to figure out how to convince us that we need to replace all of those boxes that play shiny DVDs with new HD boxes that play shiny DVDs. Good luck!

For decades, Hollywood types have been telling us that they are the real deal when it comes to sharp pictures on big screens. They sneer at what the television types are calling HD, claiming that they need 4K x 2K to faithfully reproduce what cinematographers have been capturing on film for decades.

What they don't tell us is that cinematographers will go to tremendous lengths to avoid capturing too much resolution. There's much more to the film look than the sometimes inadequate 24fps acquisition rate. Prime lenses keep only the content they want us to see in focus. Filters soften the look of images.

In short, movies (and television sitcoms and dramas) are *not* about resolution. This and the fact that the original source was captured as progressive frames are the main reasons that standard-definition DVDs look so good on an HD-capable display. The major benefit of the move to HD broadcasts of prime-time network programming has been the widescreen format, which moviegoers have enjoyed for decades.

But sports in HD is a whole new ballgame. You can actually see what's happening when the director sits on a wide shot. The instant replays have incredible detail, especially when the cameras are running in 720p mode. But most important, HD coverage of sporting events is the primary driver in the rapid growth in sales of HDTV displays.

The motivation for viewers to take the HD plunge may be the result of a neighbor inviting friends over to watch a game in HD; it may be the result of dad killing time in the electronics department while mom and the kids shop for new school clothes; or it may be the number of sports bars that are upgrading their displays to HD.

HD for the love of the game

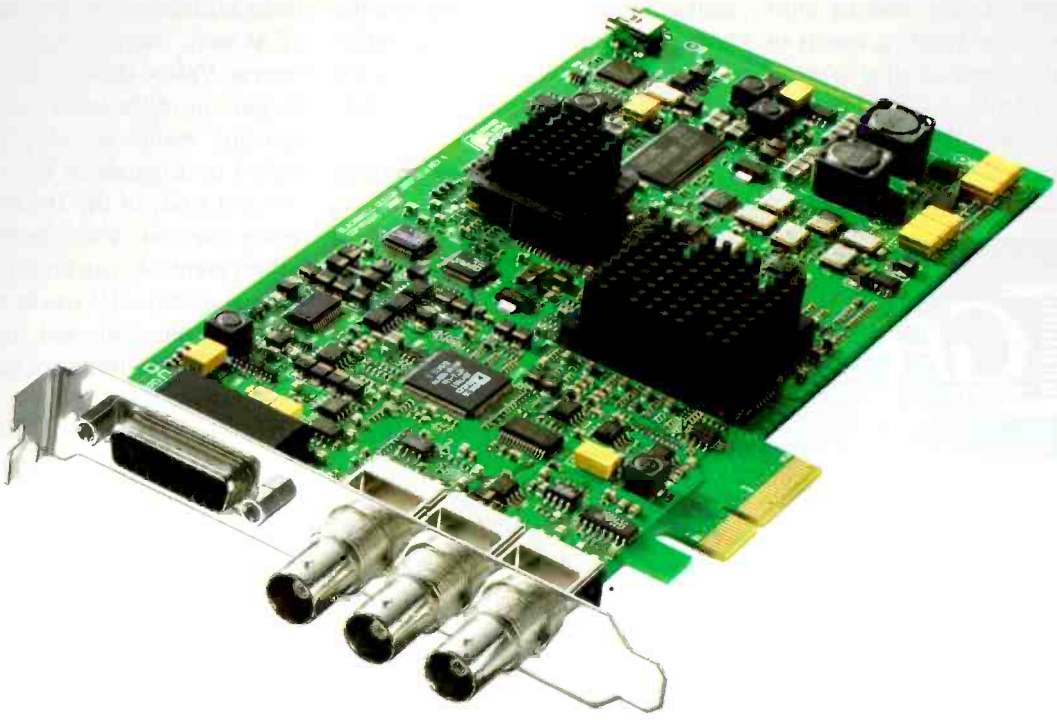
According to a news release from the Consumer Electronics Association (CEA), November and December 2005 factory-to-dealer sales of DTV products hit 2.3 million, marking a 35 percent increase over November and December 2004 sales. The CEA attributed this to the desire of sports enthusiasts to watch HDTV broadcasts of college bowl games and the Super Bowl. Overall, total DTV sales for 2005 reached more than 12 million units and $17 billion in revenue, an increase of 60 percent compared to year-end 2004. High-definition products comprised 85 percent of total sales.

As Emeril Lagasse would say, "BAM!" Talk about kicking it up a notch! Sports is the killer app for HDTV.

Apparently, the Super Bowl and March Madness have helped to sustain the momentum. The CEA reported in May that sales of digital televisions grew more than 100 percent during the first quarter of 2006. CEA president Gary Shapiro noted that more than 35 million DTV units have been sold since market introduction in 1998.

HD coverage of sporting events is proliferating thanks to national cable networks, including ESPN HD and ESPN2 HD, HDNet and InHD, and

Blackmagicdesign



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a large number of regional sports networks that are beginning to cover events in HD. And the major broadcast TV networks are covering most of their premiere sporting events in HD. To get a flavor of what is available, take a look at the HDSportsGuide.com. (See "Web links.")

Now that there is a constant supply of content, HD is transforming your local sports bars as well. ESPN Zone, the sports bar and amusement centers found in eight cities across the country, recently completed a multimillion-dollar overhaul of all its TV screens, replacing them with high-definition monitors.

What's behind this dramatic growth in coverage of sporting events in HD? It's gone mobile.

The U.S. fleet of mobile production units is undergoing a transformation of its own. Statistics supplied by the Sports Video Group indicate that 25 percent of the units used to cover sporting events are now fully converted to originate in HD. Based on a recent study of the 164 trucks now being used to cover sporting (and other) events, 41 can originate in HD. At least 10 new HD trucks will be on the road this year, and many standard-definition units are going back for an HD makeover.

Look out, Hollywood. HD movies might have been a nice starter, but HD sports is becoming the main course. BE

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

? Send questions and comments to: craig_birkmaier@prismb2b.com

Web links

"Moves to list of importance for HDTV viewing, sports a close second," Oct. 21, 2004, *http://broadcastengineering.com/newsletters/hd_tech/20041021/movies-tv-hd-20041021/index.html*

"Super Bowl XL kicks off the year of HD, says CEA," Jan. 30, 2006, *www.ce.org/Press/CurrentNews/press_release_detail.asp?id=10941*

"DTV sales up more than 100 percent during Q1, announces CEA's Shapiro," May 8, 2006, *www.ce.org/Press/CurrentNews/press_release_detail.asp?id=11015*

"HDTV redefining sports bars," June 12, 2006, *http://seattletimes.nwsource.com/html/businesstechnology/2003055504_bthdtvbars12.html*

A program guide for nation HD sports broadcasts, *www.hdsportsguide.com*

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Satellite importation

New rules have been proposed for distant DTV signals.

BY HARRY C. MARTIN

The FCC has begun to address some of the regulatory logistics associated with satellite importation of distant signals into local TV markets.

Current regulatory regime

In December 2004, Congress enacted the Satellite Home Viewer Extension and Reauthorization Act of 2004 (SHVERA). Among other things, SHVERA amended Section 339 of the Communications Act to permit satellite carriers to import distant digital network TV signals under certain circumstances.

As is the case with satellite importation of analog distant network signals, one key issue is whether the subscriber is eligible to receive such a service. Eligibility is based on whether the subscriber is served by the signal of the local affiliate of the particular network. If the subscriber already receives the local signal, then ordinarily the subscriber would not be eligible to receive a distant network signal. If the customer is located within the local affiliate's market area, the satellite carrier may not provide distant signal service. And in order to receive such service, the customer (or the carrier on behalf of the customer) must seek a waiver from the local affiliate.

If the local affiliate refuses to grant the waiver, then the customer may request signal testing to see if the actual signal of the local affiliate covers the subscriber's location. If such testing shows that the subscriber does not receive the local affiliate's signal, then the subscriber may receive distant signal service from the satellite carrier. In the case of a subscriber seeking importation of a distant digital signal, the testing would determine if the actual over-the-air digital signal of the local network station meets certain technical standards in the FCC's rules. Beginning April 30, subscribers could request a waiver with respect to a local network station within the top 100 television markets or beginning July 15, 2007, for any other full-power local network affiliate.

Measuring DTV signals

The FCC proposed to use technical standards in taking measurements of digital TV signals at a subscriber's location. The Notice of Proposed Rulemaking seeks comments on whether the receive antenna should be a standard one or one with a front-to-back gain ration consistent with DTV planning factors.

With respect to measurement procedures, the notice proposes measuring the integrated average power over the signal's entire 6MHz bandwidth. The proposal also seeks comments on what to do about a possible lack of qualified, independent testers to perform signal strength tests.

Waivers for DTV signals

The FCC also released an order addressing requests from stations for rule waivers that would prohibit satellite subscribers from being eligible for exemptions from the distant signal importation ban based on the lack of digital signals at their viewing locations. Stations in the top-100 markets had to file such waiver requests by April 30 of this year, while other stations have until Feb. 15, 2007. This waiver procedure was intended to assist stations that were not transmitting their digital signal at full power, primarily due to causes that are not the station's fault. Such stations would receive a six-month reprieve from the obligation to either participate in signal tests or allow local viewers to receive imported digital signals from an affiliate of the same network. These waivers are renewable upon a further showing.

Under SHVERA, a waiver request must provide clear and convincing evidence that the station's digital signal coverage is limited due to zoning impediments, force majeure, reduction in signal strength due to side-mounting, or no availability of satellite-delivered network signals in the market. Under no circumstances may a waiver be based upon financial exigency.

The FCC granted half of the already-pending waiver requests, based on detailed and specific showings of facts under the first three criteria listed above. Almost all of the waiver requests that the FCC denied were those filed under the fourth criterion (i.e., station's digital signal coverage is decreased because of side-mounted antenna). In these cases, the FCC found that the licensees had failed to demonstrate by clear and convincing evidence that the use of a side-mounted antenna was the cause or resulted in a substantial decrease in the station's digital signal coverage area. BE

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

? Send questions and comments to: harry_martin@prismb2b.com

Dateline

Oct. 2 is the filing deadline for renewal applications and EEO program reports for TV stations in Alaska, Hawaii, Oregon, Washington and the Pacific Islands. This deadline also applies to TV translators, LPTV and Class A stations in those states, although translators and LPTV stations that do not originate programming do not have to file EEO reports.

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–Jody Eldred

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Holographic storage

Three dimensionality maximizes storage densities.

BY BRAD DICK, EDITORIAL DIRECTOR

Have you ever been to a museum or novelty store that displayed holographic images or perhaps even offered them for sale? It's amazing how three-dimensional a hologram can appear.

Well, as NAB2006 showed, holography is more than just 3-D pictures. In fact, the technology has now entered the storage arena. The company InPhase demonstrated working versions of its Tapestry HDS-300R drive, which is being proposed as tomorrow's next-generation storage platform.

The benefit isn't 3-D images, but rather storage densities never before possible. The InPhase holographic drive can store 515Tb per square inch. This results in a storage capacity of 300GB per optical disc. The company predicts disc capacity to grow to 1.6TB in the near future.

The key to such storage densities isn't simply making the bits smaller. The solution is in how the bits are stored — in three rather than two dimensions. In other words, like a hologram.

Some history

Holographic technology isn't new. In fact, it's older than I am. Never mind that's already really old. The basic theory of holography was developed by a Hungarian physicist, Dennis Gabor, in 1947. He was working on improvements for electron microscopes, not storage. Gabor was trying to increase the resolving power of his microscopes. He proved he could do so with a light beam and ended up producing the first hologram.

Unfortunately, it took until the 1960s to develop the laser to make holograms precise enough to create clean images. Two engineers at the University of Michigan, Emmett Leith and Juris Upatnieks, developed the first device that created the kind of 3-D images many of us have seen. Today, holography is used in a variety of ways, from creating counterproof images on credit cards to three-dimensional magazine covers.

Magnetic tape and optical and magnetic discs are stored in an X-Y, ... sequential manner. By adding a Z, or depth plane, holography allows the storage of far more data in the same space.

How it works

Magnetic tape and optical and magnetic discs store data in an X-Y, two-dimensional, sequential manner. By adding a Z, or depth plane, holography allows the storage of far more data in the same space.

The storage process relies on creating a unique pattern signal, called interference, which represents the actual data to be stored. (See Figure 1 on page 26.) To generate the interference pattern, the holographic recorder uses two beams of light.

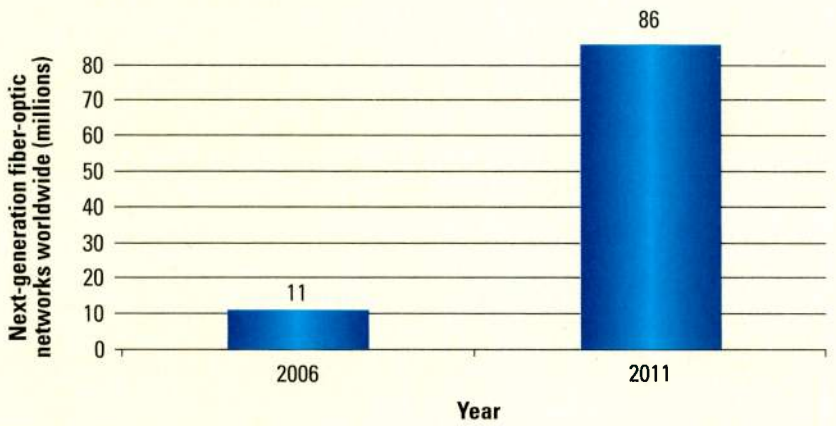
A single coherent light source, a laser, is first separated into two beams with a beam splitter. One beam is called the signal beam (the data-carrying beam); the other is called the reference beam. The signal beam — passed through a Spatial Light Modulator (SLM), which is an array of pixels — is fed digital data. (See Figure 2 on page 26.) This data can be any type of digital information, digital video, financial records or e-mail.

FRAME GRAB

A look at tomorrow's technology

Projected growth of fiber-optic networks in homes

Currently, 11 million homes worldwide receive fiber-optic networks.



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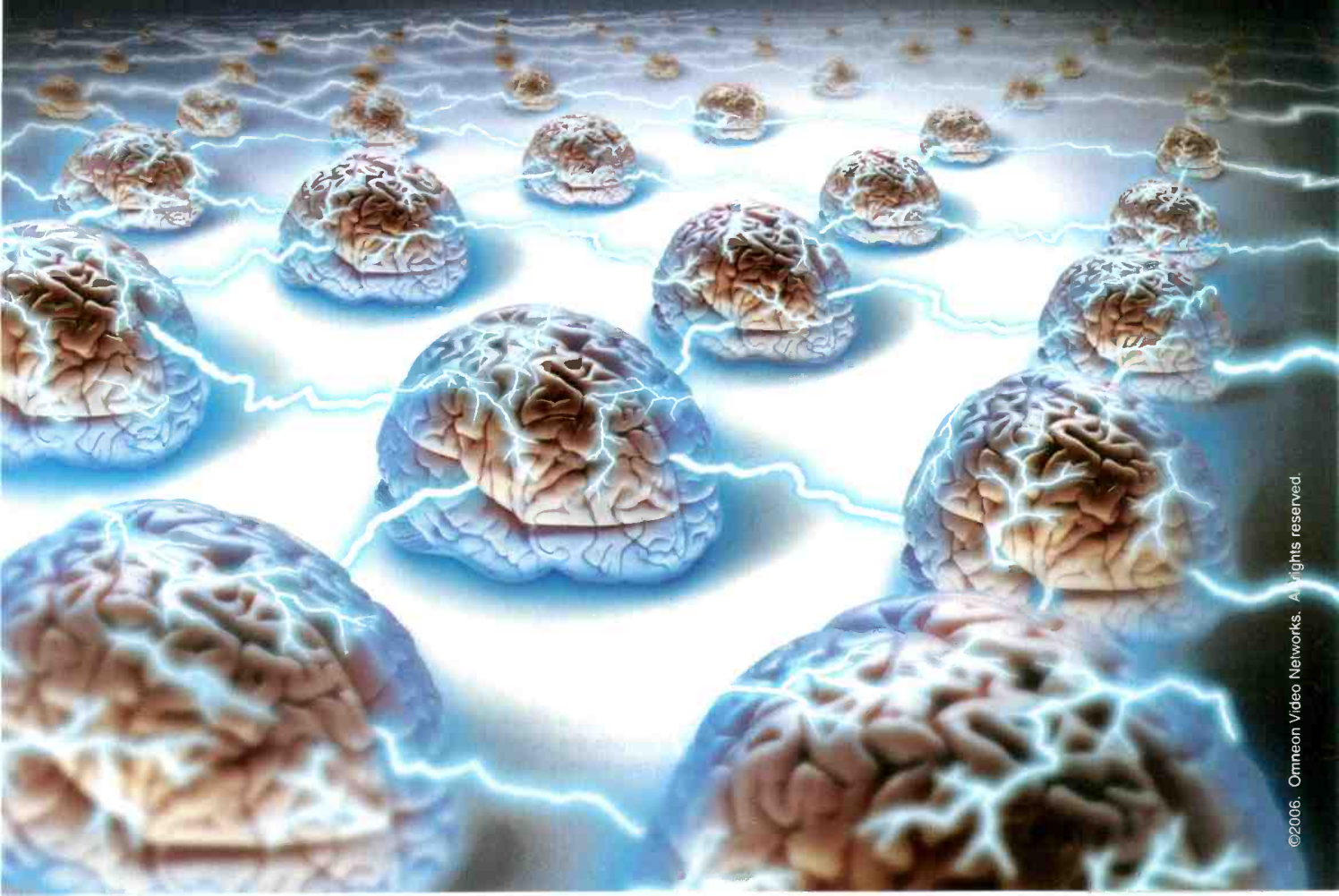


The SLM is responsible for encoding (modulating) the bits onto the signal beam. The chip converts the data into a visual display of light and dark pixels, which are illuminated by the signal beam. Typical SLM pixel counts are in the 1 million range. As the signal beam passes through the SLM, it is modulated and continues on toward the storage medium.

The modulated signal beam crosses the reference beam near the surface of the recording medium. The interference signal — created by the intersection of the reference beam and modulated data beam — gets recorded.

To move the storage around the recording surface, the reference beam's angle or media position is changed. This produces the many different holograms (called data pages) that can be recorded in the same physical place in the medium without interfering with each other. The result is a disc with high storage densities because each single physical location can hold multiple holograms.

To recover the stored data, it's a simple matter of shining the reference beam onto the stored hologram. (See Figure 3 on page 28.) The reflection of the reference beam from the stored interference pattern is projected on a CMOS camera detector array, which recovers more than 1 million bits of data in parallel or with one exposure of the laser.

Typically, a detector chip is capable of outputting 500 frames or pages of data per second.

The parallel output of the CMOS array allows an entire page of information to be read at one time. Typically, a detector chip is capable of outputting 500 frames or pages of data per second.

The key to recovering the data from the holographic storage is

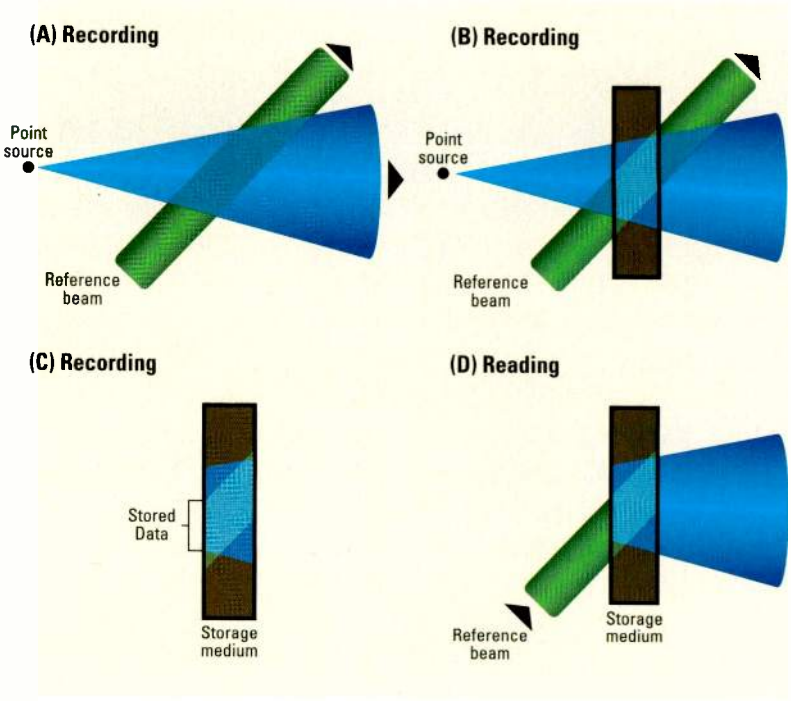


Figure 1. (A) Creating a hologram relies on the generation of an interference pattern from the crossing of two laser beams. One beam contains the data, the other the reference signal. (B) A photosensitive medium is used to record this interference pattern, or hologram. (C) The data hologram is the image of the data pattern stored within the photopolymer medium. (D) The original data can be recovered by shining the reference laser at the stored hologram at precisely the original angle. Figures courtesy InPhase Technologies.

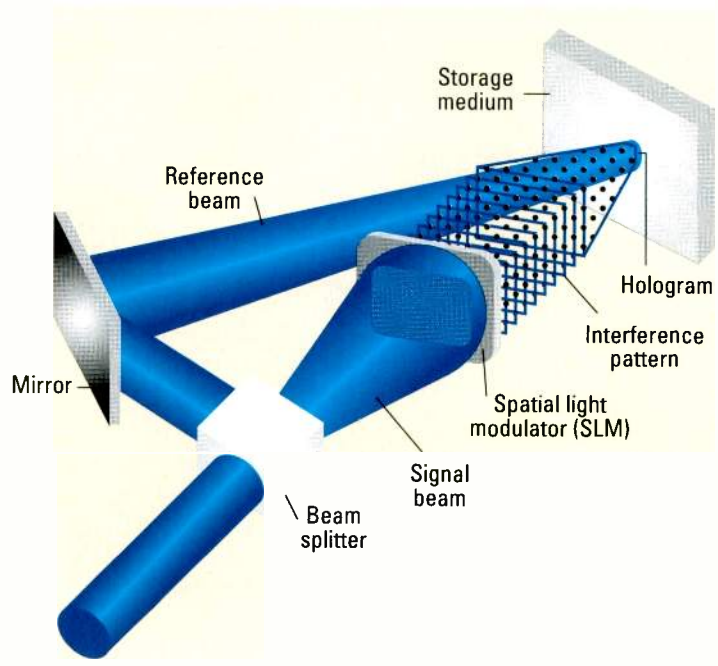
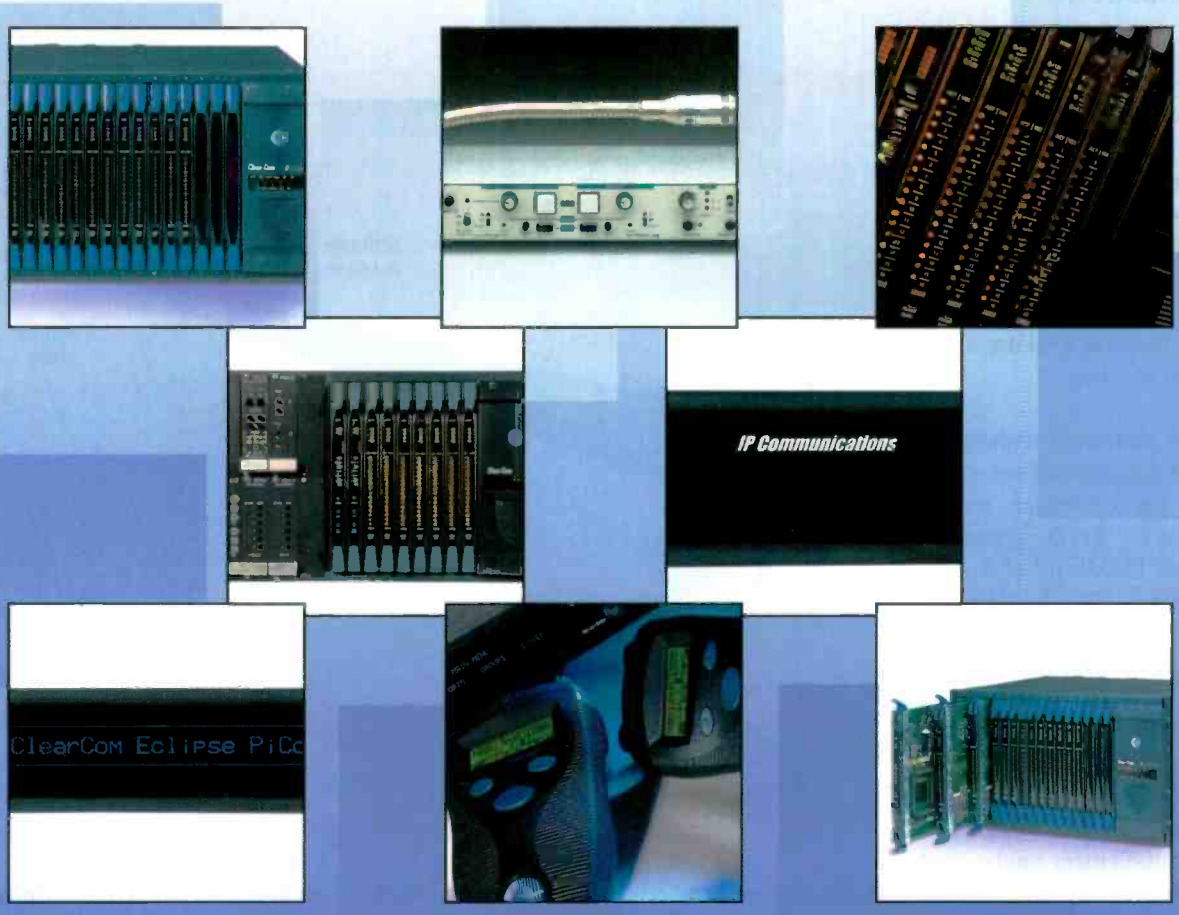


Figure 2. To record the data, a single laser beam is first split into two beams: a signal beam, which carries the data, and a reference beam. The data hologram is formed where these two beams intersect.



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precise alignment of reference beam with respect to the storage surface. This beam must precisely match the original angle of the recording beam. A difference of one thousandth of a millimeter in the beam's angle will result in a failure to recover the data.

The storage medium

The holograms are stored on photopolymer media. Today's DVDs provide about 120Mb/in^2 of storage capacity. The holographic disc will provide 515Gb/in^2 of storage capacity.

The two beams write the pages of data in the 1.5mm recording layer of the 3.5mm-thick disc. This layer is filled with two photopolymers sandwiched between the upper and lower 1mm substrates. The InPhase Tapestry recorder uses a 407nm blue laser, providing average record and readout times of 2ms.

More than 300 pages are recorded in a single location, and this collection of pages forms a book. Each page can hold 1.2Mb of user data.

The first question asked by potential users is: How much storage can holographic technology provide? Figure 4 compares the holographic storage capacities for some typical applications. Depending on the task, even small form factors can provide high capacity and performance. For instance, a 2cm postage-stamp-sized recorder (e.g., a Flash-like device) could provide from 2GB to 20GB of storage. A Maxell optical disc provides enough storage to hold 462 CD-ROMs. Or, the same optical disc can store up to 24 hours of SD video or seven hours of HD video.

How much storage? A 2cm postage-stamp-sized recorder could provide from 2GB to 20GB of storage.

The second question from potential users concerns transfer rates. Here again holographic performance is good. A Tapestry disc can provide a transfer rate of 20MB/s, which equates to 160Mb/s.

Other vendors

While InPhase was the first to launch the technology as a

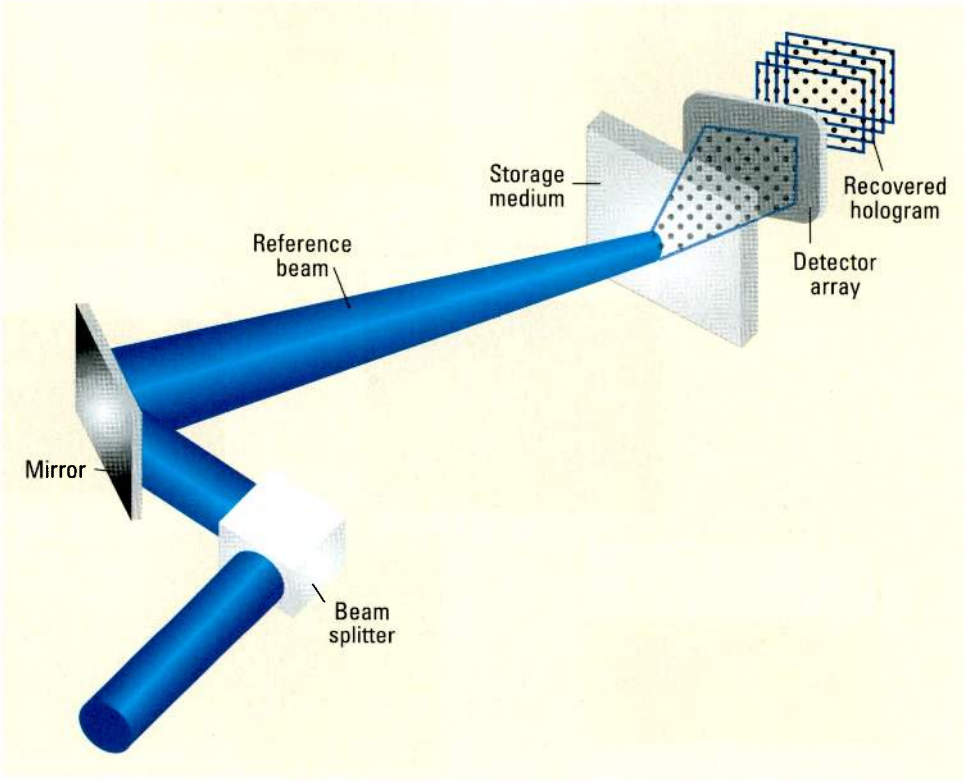

Figure 3. To read the data, the reference beam deflects off the hologram, reconstructing the stored information. The resulting hologram is projected onto the detector, which reads the data out in parallel.

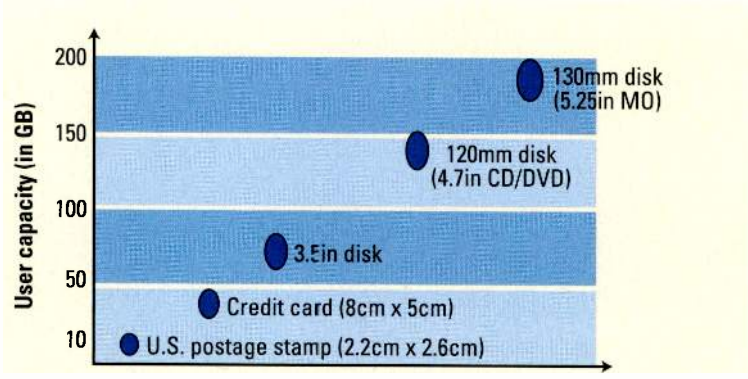

Figure 4. Holographic storage provides tremendous data storage in small form factors. A postage-stamp-sized space can contain up to 20GB of storage; a disc can store 300GB.

professional product, other vendors are vying to produce similar items for consumer products.

Last year, Toshiba, Intel Capital and others invested in another holographic optical storage developer, Optware. Optware is proposing a Holographic Versatile Disc (HVD), which is the same size as a DVD. The HVD will store 1TB of information. That's 200 times more data than what a typical DVD holds. The company claims transfer rates of 1Gb/s, or about 40 times a DVD's throughput.

While still a holographic storage technology, the Optware system relies on coherent-path laser beams. This means the reference and data beams move along the same axis. The company believes this will allow the development of more consumer-friendly (i.e., low-cost) players. Optware has proposed the HVD be declared a standard with the modest capacities of 100GB for ROMs and 200GB for cartridge-enclosed HVD-R products.

The second question .... concerns transfer rates. A Tapestry disc can provide a transfer rate of 20MB/s, which equates to 160Mb/s.

Broadcast applications

While all this may sound like future hardware, it's not. Pappas Telecasting has announced it will be the first to integrate holographic storage into a broadcast facility. The company is building new, state-of-the-art studios to serve KAZR-TV/KREN-TV in Reno, NV.

The company's new automated master control facility, called the Crystal Palace, is being constructed at an indoor Reno shopping mall. The facility will house two local high-definition news studios, one for each station. The HD studios will integrate the InPhase holographic storage platform into an automated program archive system.

Just when you thought the stoage race was only between Blu-ray and HD-DVD, something new and potentially better pops up. Stay tuned; the storage front is getting exciting. BE

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Video over IP

The technology is becoming the natural choice for the delivery of video.

BY BRAD GILMER

Video over IP is the delivery of video and audio (usually compressed) over packetized networks using Internet Protocol (IP). (See Figure 1.) Video over IP is directly tied to the history of the delivery of video and audio over wide area networks (WAN). While it may seem to be a new development, it really is a logical extension of what has come before.

ATM over SONET networks

Years ago, AT&T was *the* telephone company. It provided both local and long-distance voice service. In the 1950s, AT&T built special, nationwide networks for delivery of programming from the big three networks (ABC, CBS and NBC) to affiliates all over the country. This distribution network was a combination of balanced coaxial cable and point-to-point microwave, and it incorporated a lot of purpose-built video equipment.

For many years, this network operated alongside the national voice network. All major cities (and some smaller cities) had dedicated video departments.

In the 1970s, AT&T broke up. The Baby Bells were created to handle local and regional telecommunications, while AT&T handled long-haul communications. In the '80s, phone companies began to switch from wire to fiber. Fiber allowed the phone companies to increase capacity, while reducing costs. They deployed synchronous optical network (SONET) technology as the base layer for their voice and data network, and this technology is still in use today.

During the same period, analog voice circuits were replaced with digital voice transmission, which allowed the telephone companies to multiplex many voice circuits onto a single copper pair and, later, onto a single fiber-optic cable. In the space of a few years, the core telecommunications infrastructure changed from copper/analog to fiber/digital.

The telephone companies decided to use a technology known as asynchronous transfer mode (ATM) to package digital voice data for transmission and switching. Among other things, ATM defines the rules about how data packets are constructed and how connections are established.

As the computer came of age, telecommunications companies began to move significant amounts of data. Data fit well into the ATM over SONET protocol stack. And as computing technology evolved, IP became the dominant networking technology. The telecom industry dealt with this by encapsulating IP into ATM and then transmitting it over SONET networks.

In the meantime, video also transitioned to ATM over SONET for most long-haul applications, but the last-mile delivery of video from the telco central office to the studio could be anything — ATM, dedicated fiber-optic cables or old balanced coax.

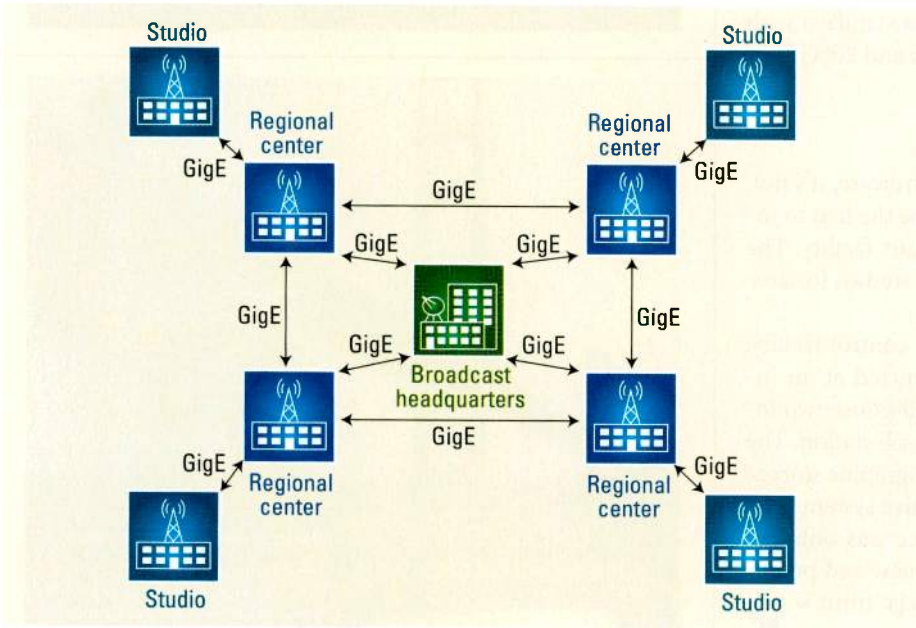

Figure 1.Video gateways, such as the one shown above, can help broadcasters increase their reach by linking with other facilities and stations while minimizing costs and reducing latency. Figure courtesy Path 1.

IP over SONET networks

About five years ago, the telecom industry made the momentous decision to change its core networks from ATM over SONET to IP over SONET. The telcos realized that virtually all of their data traffic was IP-based and that there were significant savings to be realized in converting voice traffic to IP. Once this decision was made, the transition from ATM to IP seemed to happen overnight.

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This rapid transition left video in a predicament. Many large broadcasters had national ATM networks in place, connecting key cities such as Atlanta, Los Angeles and New York.

Broadcasters knew that it was not an option to keep their ATM over SONET networks forever. Once the telcos made the decision to go with IP, it was only a matter of time before broadcasters had to follow. Broadcasters faced the difficult and costly question of when to replace their ATM over SONET networks with IP over SONET networks.

Broadcasters are taking advantage of core telecom IP networks for the transport of video over IP.

Over the years, many of the video specialists retired from the telephone companies — and they were not replaced. With a few notable exceptions, it was almost impossible for a broadcaster to reach someone at the telephone company who knew much about video. As the telecoms moved to IP over SONET, they spent a great deal of effort training technical people to manage these networks. Their research laboratories have conducted some of the most cutting-edge analyses of delivery of video, voice and data over IP networks to the home. If broadcasters wanted to take advantage of this knowledge, they would have to convert to IP over SONET — and sooner rather than later.

It is only natural that video over IP is becoming a major transport technology in our industry. History and changes in technology have conspired to make it the natural choice for delivery of video, whether for contribution or delivery to the home.

Two domains

Video over IP can be split into two domains: contribution and delivery to the home. In the contribution domain, delivery of video over packetized networks is typically referred to as video over IP, while video to the home is typically referred to as IPTV. By contribution, I mean video and audio that is sent from a remote venue back to a television studio or post-production facility. Delivery of video to the home typically is part of the video, voice and data triple-play service.

User requirements for contribution video are quite strict. For example, users may require low latency for live interviews (100ms), high uptime requirements (99.999 percent uptime is not unusual), and video and audio quality requirements that essentially require bit-perfect delivery of content from one end to the other.

Another requirement is that the cost of this new digital IP-based service must be in line with traditional video delivery, which has been provided to broadcasters since the 1950s.

Challenges

While the user requirements seem reasonable from a broadcaster's point of view, they pose some real challenges for video service providers. An example of a conflict in user requirements is a broadcaster's requirement for high uptimes. To achieve anything near 99.999 percent availability, service providers have to address two core issues: maintenance and momentary outages.

Moving to IP allows broadcasters to stay in the well-maintained core of the telecom infrastructure. However, the concept of what constitutes an outage in the data world is significantly different from that of the broadcaster's.

Given that most data customers are not significantly affected by occasional outages, telecom maintenance personnel and IP network equipment vendors design maintenance plans and equipment specifications so that occasional disruptions occur. As an example, if a core
network will reconve
switch in a matter of j
onds. This is a good thin
casters — it means that the
self-healing. However, when
router is repaired and returne
vice, frequently the network ta
other hit as the network recon
on the repaired router, causing
outages instead of one. This is
one example of how maintenance
data networks can cause problems fo
a broadcaster.

To deal with momentary outages caused by dirt in connectors or impulse noise, most video service providers use forward error correction (FEC). This scheme adds additional bits of information in the transmitted stream. If data is lost, the extra FEC information allows the receiver to reconstruct the transmitted data.

However, FEC adds overhead to the stream — perhaps as much as 20 percent in a typical application. It also adds latency. The exact amount of overhead and latency is determined by the severity of errors the FEC is designed to handle. Equipment designers work carefully to balance the typical distribution of errors on a network with various parameters in a given FEC scheme to come up with a well-designed system that can recover from most network errors, while incurring a minimum of overhead and latency.

Conclusion

Video over IP is destined to become the predominant technology for the transport of professional video over WANs. Broadcasters are taking advantage of core telecom IP networks for the transport of video over IP. However, challenges exist when broadcasters' user requirements produce conflicting design criteria. BE

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

? Send questions and comments to: brad_gilmer@prismb2b.com

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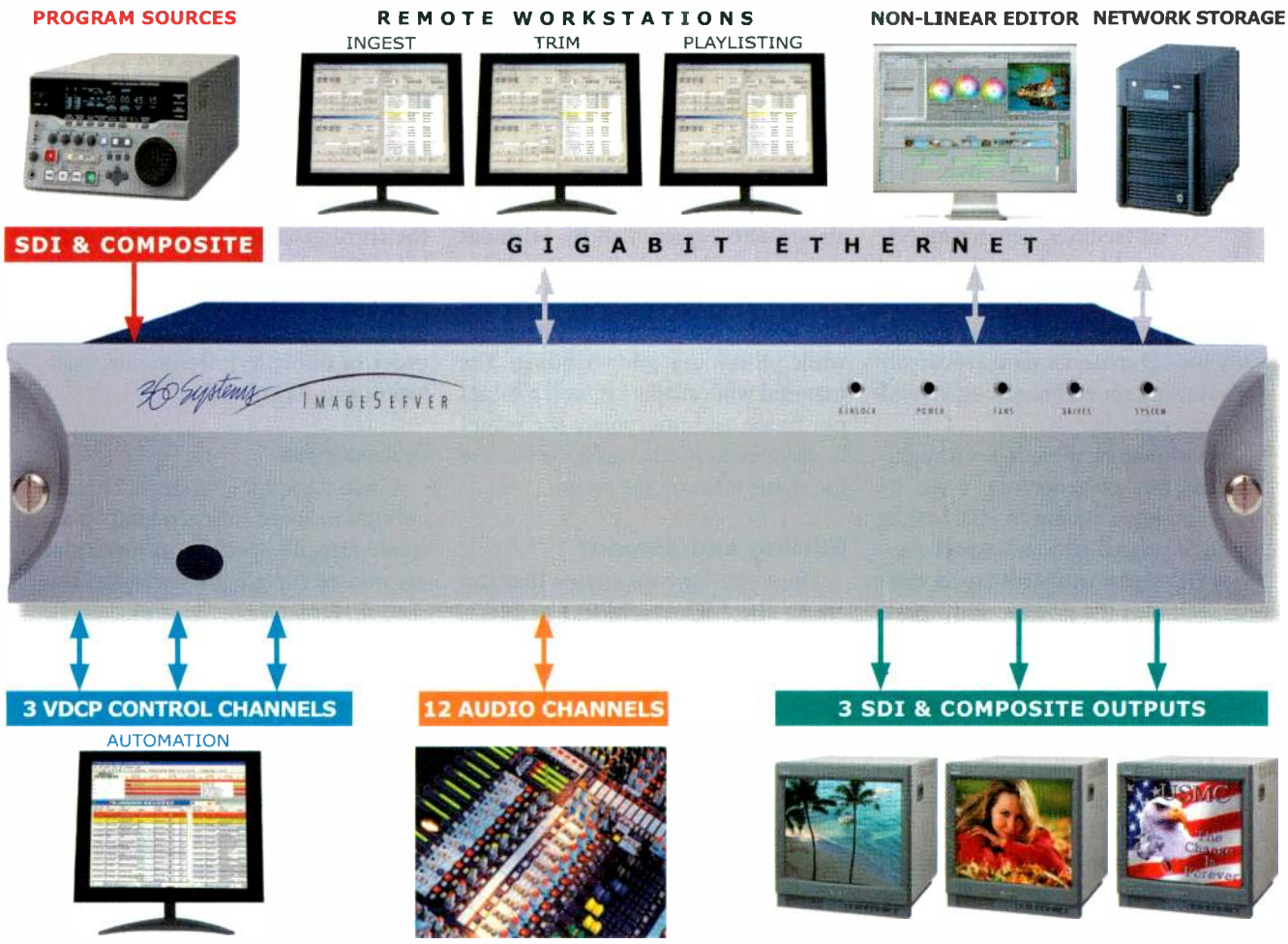

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HD graphics

Here's your guide to an SD/HD management system.

BY NIR GOSHEN

For the stations that have made the transition to digital facilities, generating HD graphics often remains a challenge. Stations usually have a large library of graphics designed specifically for SD material used repeatedly on news and sports broadcasts, as well as in interstitials.

Unfortunately, there is no straightforward way of generating video by an SD graphics system to HD. Scaling up an SD signal with 4:3 aspect ratio to an HD signal with 16:9 aspect ratio will both blur the graphic and stretch it horizontally. For example, a sharp SD circle will look like a blurred oval on an HDTV set. While there is still a large audience for analog or SD signals, you don't want to alienate the HD audience. Fortunately, there are ways to make both sets of viewers happy.

Any new graphics system obviously must handle both SD and HD. The hardware would typically be the latest generation of high-performance, rack-mountable PCs, running graphics rendering software and broadcast design software.

Resolution-independent

The graphic system should be resolution-independent, meaning that the images are implemented as vectors rather than raster-based. This allows the shapes and colors to be mathematical formulas residing in the brains of the software, and they are rendered (or created) as pixels at the desired frame rate.

For example, a circle that fills half the screen renders as 320 x 320 pixels, and a twice-larger circle renders at 640 x 640. Both circles are based on the same mathematical formula, but are handed over to the video board as a different area of pixels, so the edges maintain sharpness.

This is the case with material (color) when applied to geometrical objects. Following the same concept, materials are also represented by formulas and rendered in real time. This process maintains the desired resolution and image smoothness and sharpness while preventing color banding. The material will calculate its color values per frame and interpolate the values it allocates to pixels based on the size the shape takes on the screen.

Editing and playout

Once you have an engine that can create the high-resolution graphics, the next step is to provide both editing and playout control over them. Stations sometimes employ two types of control systems. One focuses on content creation tasks, and the other focuses on graphics playout.

Broadcasters may consider deploying either or both platforms, depending on the needs of their organization. It's typically recommended that the CG system reside on top of the same render engine so the control room operator sees precisely how the next graphics fit on-screen and can see immediately if safe limits are exceeded.

An important characteristic in a graphics design environment is the wysiwyg (i.e., what you see is what you get) aspect. Without this feature, the designer has to guess how the graphics will look in the final output. For example, take a designer who is trying to compensate for the anemographic distortion between 4:3 and 16:9 images without the benefit of both types of viewers to see the images. Without the wysiwyg capability, the designer may end up with either great-looking SD or HD graphics, but seldom both. In a multiformat environment, maintaining the wysiwyg capability during the design process can save many working hours and result in more compatible images over different types of TV screens.

Once a new graphics hardware and software platform has been installed, the art of graphic design can be tackled. When broadcasting graphics in multiple video formats, there are three main challenges (in increasing order of difficulty): frame rate, resolution and aspect ratio.

Frame rate

When graphics systems handle animation speed independently from frame rate, no special considerations are needed for graphics without animation. Broadcasters adopting an HD standard with the same frame rate as their existing SD standard will incur no frame rate issues.

Resolution

The resolution of the video standard is relevant when working with pixel-based graphics such as stills and video clips. Obviously, an HD image has a greater resolution than one created in SD. The 1080i HD format has almost six times more pixels than that of an NTSC SD signal. Other graphics elements will scale gracefully between resolutions when using a vector-based graphics system. When presenting pixel-based graphics in higher resolutions, you may find that the result will look blurred and diffuse if the pixel graphics are not of sufficient resolution.

If you have a small stock of high-resolution stills, now is the time to begin building a library with a resolution sufficient for HD. The library of HD-ready stills can be used for SD viewers as well, because the software will automatically downsample stills to the appropriate resolution.

That being said, downsampling might also show some artifacts if the graphics device does not support mipmap. Mipmap is a method where once an image is loaded, several versions of the image are automatically

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created in lower resolutions. Mipmap blends between the resolutions as per the total area that the image takes on-screen, creating an average-based resolution. (See Figure 1.)

Aspect ratio

Designers should carefully consider their image's displayed aspect ratio when the image needs to cover specific portions of the screen. Consider a lower-third banner graphic designed for SD that extends across the whole width of the screen. What portions of an HD widescreen would you want the graphic to cover? This is comparable to the difficulties encountered when adapting widescreen moves for 4:3 broadcast, except the width and high dimensions are reversed.

What do you do for your HD audience when you don't have enough 16:9 graphics for broadcast? There are four main strategies for dealing with aspect ratio issues:

- padding the sides or the use of ears;
- trimming the height;
- stretching the height; and
- changing the layout of individual structural elements.

The first three are essentially stop gap measures. They provide methods of outputting HD graphics, which will keep your HDTV audience satisfied until you can start sending them true HD, 16:9-friendly graphics.

Padding the sides of the graphics will retain the aspect ratio of the graphics, but will leave blank areas on either side of the graphics. This strategy requires no effort because it can be completely handled by the graphics engine. However, graphics that previously stretched across the full width of the screen may look strange when they no longer reach the side screen's edges. This solution works well for graphics installations that only display side panels on either the left or right edge of the screen, because you can easily keep the panel aligned with its screen edge.

Because the market is still in transition for both the consumers and the content provider, it is likely that we will continue to see the HD ears for some time. The blank HD ear space can be used for sponsor logo, schedule information, game scores, etc. (See Figure 2.)

When designing new graphics or redesigning existing graphics in a system that uses this strategy, the artist can accommodate both SD and HD aspects by extending background plates and other nonessential graphics to the edges of HD, while keeping important graphical elements within the safe area of SD.

In this case, the whole production is completed in HD and then downsampled to create the SD version. This approach is less expensive than producing both SD and HD graphics in parallel. Plus, only one HD graphics device is required, as long as it can handle both SD and HD.

Stretching the height of an SD signal to span across the height of an HD signal can be done without cropping or changing the aspect ratio of graphics as long as the graphics don't use the full height of the screen. This also requires no effort. The downside is that the proportion of the screen height used by the graphics will increase. The lower-third banner graphics designed for SD would cover only 4/9 of the height on an HD screen — not a desirable result.

Stretching the whole graphics horizontally to fill the HD widescreen also requires no effort. The downside is that it changes the aspect ratio of the graphics. Stretching will change perfect circles into ovals. However, unlike converting an SD signal to an HD signal, there will be no blurring, because the graphics system will render it with the appropriate resolution. Many graphics look fine after being stretched. Although, certain graphical elements such as circles, squares, natural photos and some text fonts will look odd after being stretched. Also, sponsors tend to dislike their logos being stretched or changed.

The best results are achieved by changing the layout of the individual structural elements of graphics designed for SD before broadcasting those same graphics in HD. While this requires more effort, it surpasses all other strategies on an aesthetic level.

Figure 1. The mipmap of an image at 1/2, 1/4, 1/8 and 1/16 of the initial image resolution

The human factor

Good graphics design tools can simplify the process of converting SD graphic layouts to HD. And, this eliminates the need to recreate the HD graphics from scratch. However, someone still needs to inject the artistic sense and sensibility that will make graphics look good in 16:9. The artist will pick elements and adjust their size, position and aspect ratio to make the graphics look better. Easy-to-use graphic design tools that can arrange elements in nested groups and allow the graphics artist to operate on both individual elements and groups of elements can greatly simplify this process.

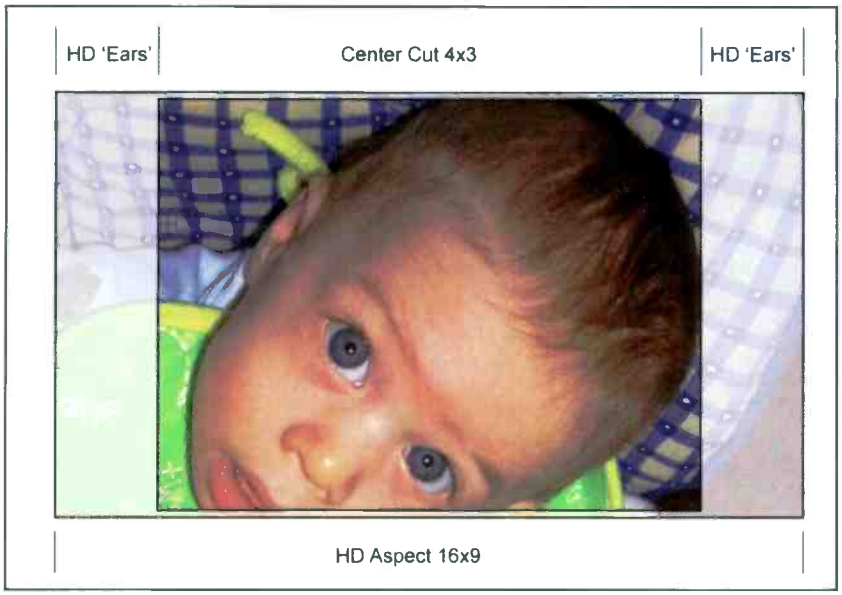

Figure 2. The center cut for 4:3 with extra ears for 16:9

The front end

Another important aspect must be considered: the database and front-end CG airing tools. When shooting to air two or more sets of graphics, two or more sets of files (scenes or pages) are called simultaneously. When a designer fixes something in the HD page, he must be able to track and determine whether these fixes need to automatically take place in the SD page. This means that a single CG front end needs to be configured to work with multiple databases simultaneously.

New channels

Once you've got all these issues in mind and have identified a solution, you're not done. Broadcasters are learning that they have a tremendous opportunity to serve other channels. Those new channels could be 3G broadcasts, podcasts, webcasts and VOD on the Web.

Each of these platforms has unique graphic and image needs. Many of today's graphics platform manufacturers are working now to develop these solutions. While that shouldn't drive today's HD graphics purchase decisions, a unified graphics platform serving all these new channels may be a good solution down the road. BE

Nir Goshen is the creative director at Vizrt.


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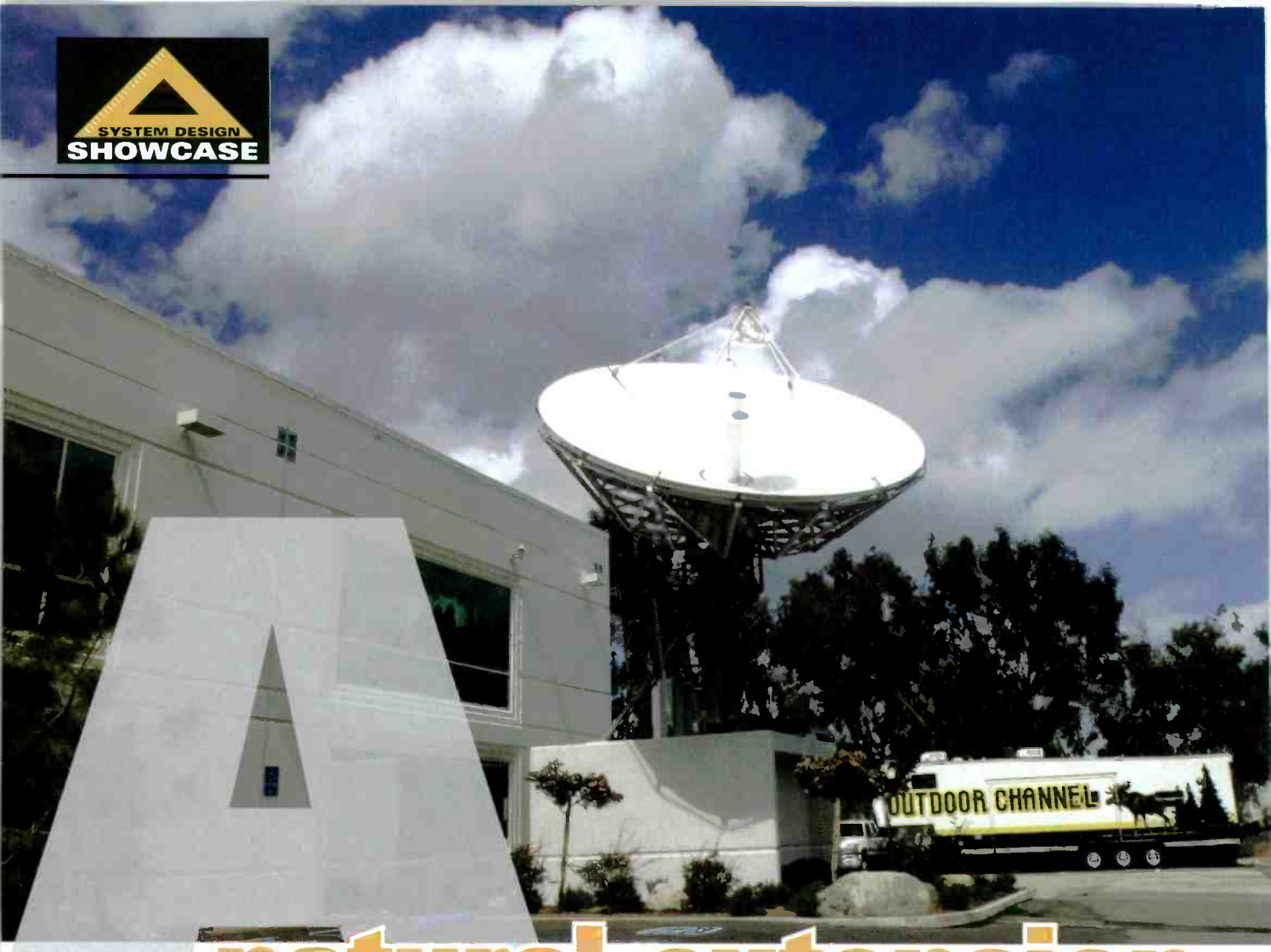
SYSTEM DESIGN SHOWCASE



natural extension

The Outdoor Channel bases its design from its content.

BY LOUIS LANDON

The Outdoor Channel (TOC) in Temecula, CA, began in 1991 as a family-run cable channel offering hunting, fishing and gold prospecting programming to a small, like-minded and passionate audience. Today, it has nearly 27 million viewers and has crafted its message to directly attract the nation's 82 million anglers, hunters and outdoor recreation enthusiasts.

TOC's mission is to continually offer the highest quality of original, family-oriented content and to have the most respected, authoritative and entertaining personalities in the outdoor programming arena. Always using the latest technology is an important element in consistently delivering the best possible product to subscribers.

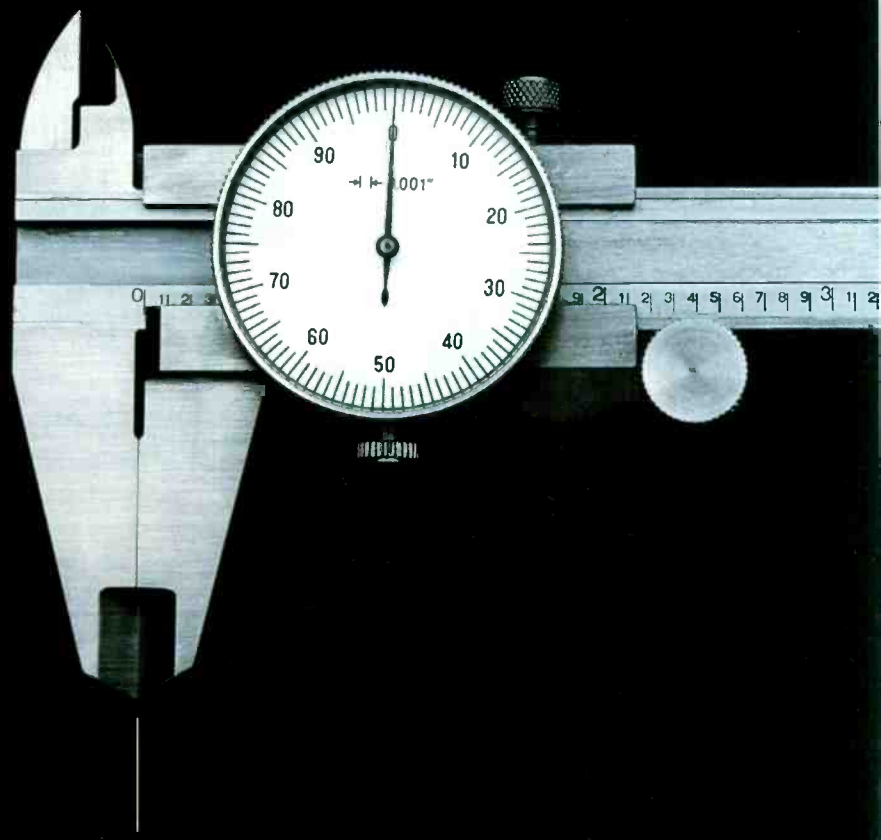
Room for growth

The need for a new broadcast facility arose out of TOC's phenomenal growth. The 2005 launch of a separate 24/7 all-HD channel, Outdoor Channel 2HD, ultimately drove the network to seek a larger, more consolidated and technologically advanced operations space. Now, TOC sits in a 39,000sq-ft HD facility designed by Studio 440, an architectural firm in Los Angeles.

Working closely with Atlanta-based Technical Innovations Broadcast Solutions Group (TIBSG), TOC began the process by identifying some primary design criteria. Ideally, TOC wanted a facility that would maximize workflow; improve media management, preparation and playout; bring the satellite uplink and compression systems in-house; and provide all technical systems with substantial expansion capabilities.

Architecturally, TOC wanted to showcase its state-of-the-art systems in a way that would accommodate visitor tours and walkthroughs. And it was important that the new building evoke the spirit of the outdoors in its

The 7.2m VertexRSI satellite uplink antenna from General Dynamics C4 Systems SATCOM Technologies sends The Outdoor Channel's signal up to the Panamsat G10R satellite. Photos by Tom Kelsey, The Outdoor Channel.



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Leitch servers and Scientific Atlanta compression equipment are used in the central equipment room.

design and implementation.

TOC purchased an available building across the street from its existing site. This made supervision of construction easier at a time when attention needed to be given to the launch and initial programming demands of the new HD channel. TOC and TIBSG employed a phased project approach, ensuring that each crucial decision would be carefully planned, scheduled and executed in the most effective manner.

Carving its mark

During the initial design phase, TOC, TIBSG and Studio 440 arrived at an innovative concept to align master control, media operations and the central equipment room as a primary technical core. This core is enclosed within a custom-glazed partition system. The facility's ancillary functions are organized around the core, configured to provide views back into the technical space. A pathway goes around through the core areas.

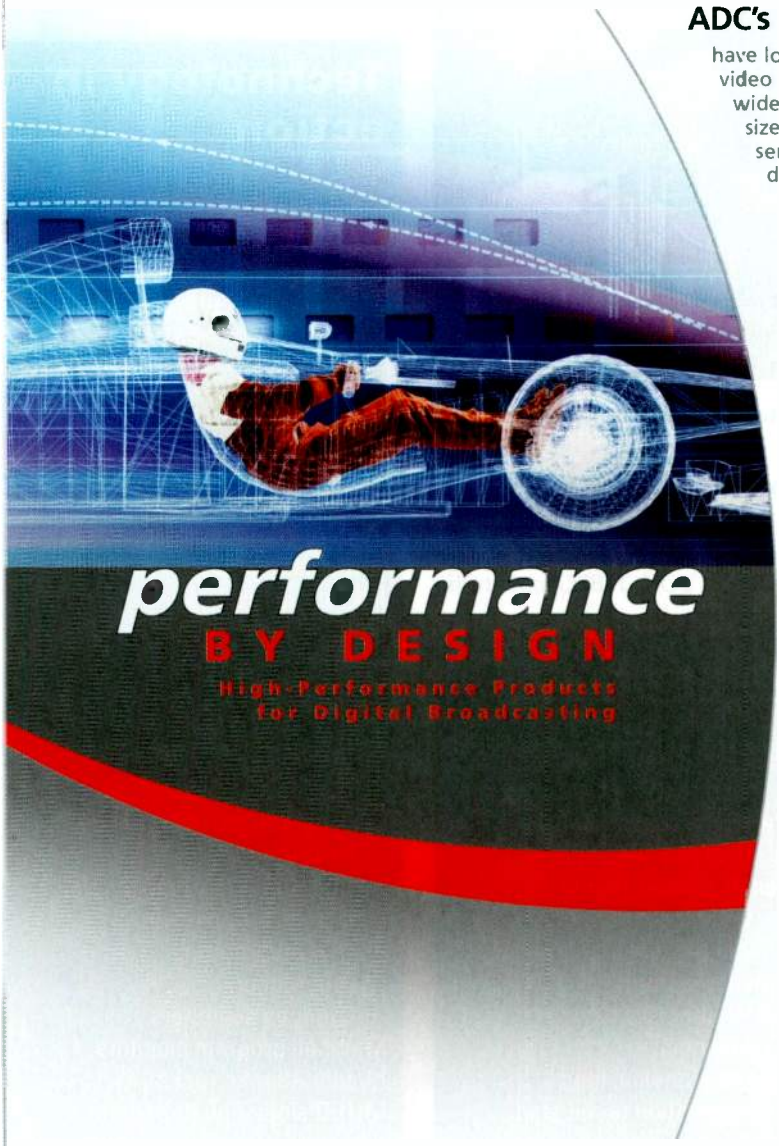
Once construction commenced, an 18in cavity was carved out of the one-time Temecula tire factory's foundation to accommodate signal cables, electrical services and fire protection services below a new access floor system. An interstitial ceiling space conceals mechanical, lighting and additional fire protection systems and creates cable pathways to the upper level digital edit bays.

Providing all building services from above and below eliminated the need for localized equipment and electrical rooms. The result is an uncluttered, refined core, open on all sides for views and circulation.

TOC's new broadcast center is a hybrid of HD and SD digital and analog video and audio systems. And all allow for future upgrades in space and technology. This includes the Leitch NEXIO HD server platform, SuiteView wall processors and Integrator GOLD routing. TIBSG coordinated the Forecast custom consoles to complement Studio 440's interior design concepts. Some of the other technical highlights of the facility include two SDI streams for the East and West Coasts, one HD stream; eight edit suites; and a media operations center with two ingest stations.

The nitty gritty

For the broadcast center's new in-house compression, the Scientific Atlanta PowerVu system encodes the HD and SD channels and then multiplexes them onto a single ASI bit stream for modulation and uplink. The user interface, the PowerVu



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The Outdoor Channel's 24-hour master control room is situated in the facility's center with media operations and the central equipment room.

network center, allows for monitoring all aspects of the compression process. It also allows engineering to manipulate bandwidths, output levels and configurations, as well as for the management of the PowerVu receiver database for customer authorization.

The Scientific Atlanta modulator in the central equipment room sends the 70MHz IF signal via coax to a transmission shelter. Inside this shelter, the signal runs through a 1:1 redundant pair of MITEQ slope equalizers and upconverters to a 1:1 redundant set of CPI 400W C-Band TWTAs for uplink. A 7.2m VertexRSI antenna sits on top of this transmission shelter, sending the TOC signal up to the Panamsat G10R satellite. All of this is tied to TOC's Crystal Computer monitor and control system, which notifies the master control operator of any system faults via a remote user interface.

TOC's new broadcast center uses a state-of the art backup generator and UPS system, as well as an FM-200 fire suppression system in the critical data areas. The network has everything needed to be self-sufficient and redundant should an emergency arise.

A natural space

With constant interaction, flexibility and creativity from the respective teams at TOC, TIBSG and Studio 440, the new facility was completed on schedule and within budget. The new facility represents a technological extension of The Outdoor Channel's established brand, complete with a moose head that hangs over the entrance to master control.

However impressive the architecture and design of the center, these elements are overshadowed by the innovative technology in use and

Design team

- The Outdoor Channel
  - Gene Brookhart, vp of operations
  - Paul Weaver, executive dir of broadcast services
  - Tom Robinson, mgr of technical operations
- Technical Innovations Broadcast Solutions Group
  - Bill Amthor, sys design engineer
  - Brian Kincheloe, lead installation technician
  - Tim Sloan, vp of engineering and operations
- Studio 440
  - Ross Brennan, architect
  - Douglas Gruninger, project mgr
  - George Newburn and Jacqueline McNaney, project team

Technology in action

- ADC video and audio patch fields
- Blonder Tongue in-house RF distribution system
- Christie 70in DLP Projection Cubes
- ClearCom intercom system
- Crystal Computer monitor and control system
- Ensemble Designs
  - Tri-level sync generators
  - HD test-set generator
- Forecast broadcast consoles
- Harris automation
- Ikegami QC monitors
- Leitch
  - NEXIO 4200HDX HD with 11.7Tb RAID storage
  - NEXIO 4000TXS SD with 11.7Tb RAID storage
  - Integrator GOLD SDI and HD routers
  - NEO SuiteView monitor wall
  - X75 HD/SD converter synchronizer
  - LogoMotion
  - Panacea switchers
- Marshall program monitors
- Middle Atlantic racks
- MITEQ slope equalizers and upconverters
- Panasonic DVCPRO recorders
- Scientific Atlanta PowerVu network center
- Snell & Wilcox HD upconverters
- Sony DVCAM and HDCAM recorders
- Tektronix waveform monitors
- Wohler audio monitoring

on display. In addition to effectively meeting TOC's current production and technical needs, this building also holds the key to the network's future with the ability to easily upgrade, expand and update the space and technology as business dictates.

As one of the more technologically advanced broadcast centers in the region, TOC also offers outside productions, broadcasters and the community at large the use of its production and editing facilities, as well as access to purchase uplink and satellite space capacity via its available bandwidth on the cable bird, Galaxy 10R. In addition, TOC has integrated fiber and downlink connectivity at the facility, as well as direct Internet connectivity — services TOC plans to offer for sale. TOC has direct fiber connectivity to Verizon and Vyvx. BE

Louis Landon is vice president of MPH PR.

The media operations area features Harris media ingest client stations.

SYSTEM DESIGN SHOWCASE

In KCNC's production control room, Clarity Lion monitors with redundant light sources are mounted on movable pedestals. Critical signals are redundantly monitored with smaller LCD displays.

KCNC upgrades production control room

BY TOM NORMAN

For many years, KCNC-TV, Denver's CBS O&O station, used an analog production switcher for newscasts and live programs. When it became time for the station to transition to digital, the production control room's equipment limitations became clear. An upgrade of the switcher as well as the entire production facility was necessary.

Design and implementation

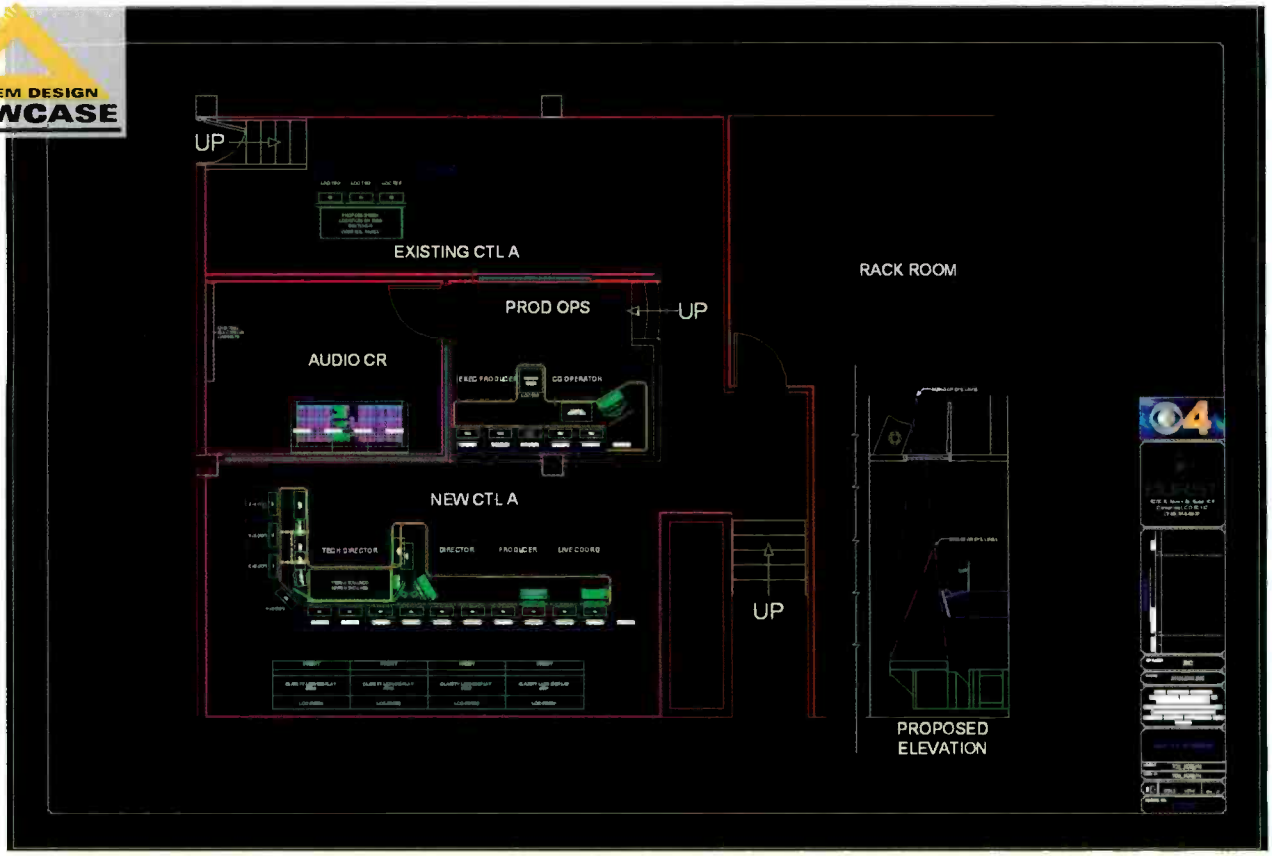
The staff wanted to improve workflow and implement HD while still controlling costs. To improve workflow, furniture was designed and constructed to minimize eye travel while enhancing visibility and operator access to control surfaces. The design required a three-part installation and implementation plan to limit the impact on the station's daily news operation. Also, the facility needed to deliver SDI signals at the onset and allow for an easy upgrade to HD-SDI later. The station selected Denver-based Burst to design and build the new production facility.

The first phase of the project focused on demolition of the space occupied by the old standby Production Control Room B and the NLE room adjacent to it. The space was reconfigured to accommodate the new video production furniture, which supports a director, technical director (TD) and associate producer, who doubles as the live coordinator. After these positions were completed and tested, the Sony MVS-8000 switcher was installed. Staff training and shadowing then started. Once the staff was comfortable with the new operation, the first newscast from the new room was aired.

The second phase began with deconstructing the space housing the old switcher and its associated operating positions to make room for the new audio booth. The new audio booth was then built along with an audio overbridge. The console and associated equipment was then reinstalled.

The design required a three-part installation and implementation plan to limit the impact on the station's daily news operation. It also needed to allow for an easy upgrade to HD-SDI.

In the third phase, the facility was readied for the CG operator and the executive producer. The old audio booth was torn out, allowing the construction of an extension of the elevated floor next to the audio booth. Installation of the remaining



Burst measured the spaces where the new facilities would be installed and created an AutoCAD drawing accurate to 1/16in in each dimension. The Clarity Lion monitors and the furniture design were then drafted to fit the available space.

furniture and equipment for the CG operator and the executive producer ended the final phase.

Equipment decisions

The new switcher met the station's needs to provide SDI now and HD-SDI in the future. The facility also installed Belden 1695A cable and matching patch panels capable of handling HD-SDI.

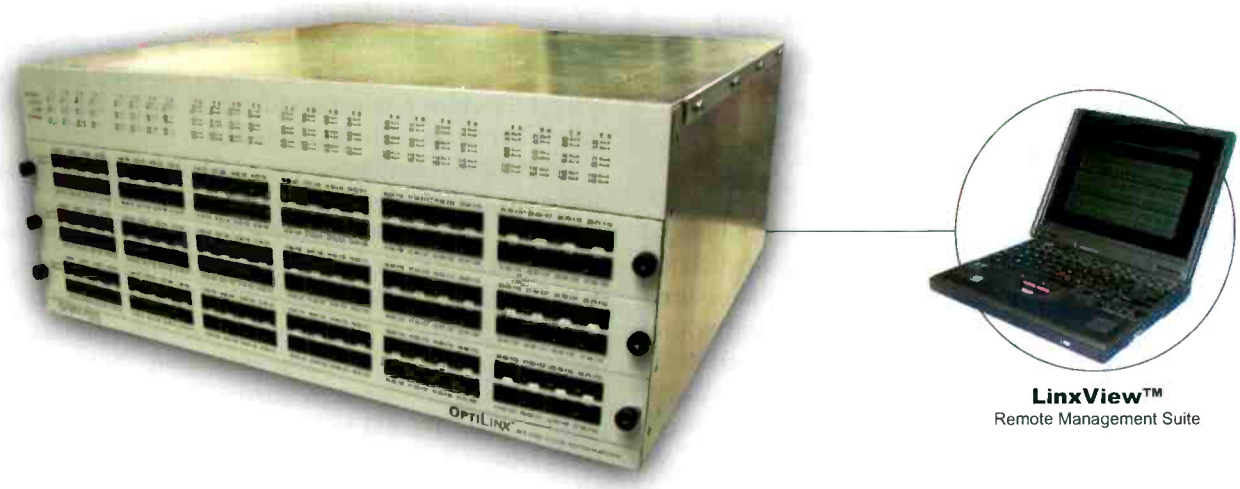
Miranda K2 Kaleido multi-image processors drive the Clarity Lion 67in rear projection monitors. The monitors require a fair amount of space, so the room design was driven in large part by their footprint and visibility from the various operating positions. Burst completed designs for the technical furniture and collaborated with interior designer Gulash Designs on the final room layout.

High Tech Furnishings designed, built and installed the furniture. The cabinetry had to support good visibility and easy operator access to key equipment. Important control and monitor surfaces were placed at an optimum range for the operator's reach. The cabinet face was tilted back for visibility, while the top two rack spaces in each cabinet were moved closer to the operator. This places the top two rack spaces closer to the operator without impacting visibility or interfering with the line of sight over the top of the cabinetry.

Gefen DVI fiber extenders feed the Clarity monitors' DVI inputs. The rear projection monitors are mounted adjacent to each other across the front of the room. Two of these monitors are located directly in front of the TD, yet the entire array is visible from all positions. Operators can view key signals for each position on nearby

A Sony MVS-8000 switcher is the centerpiece of the technical director's position in the new production control room.

It's time to switch.



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Part of the news operation involves a room called News Gathering Operations. This room is located adjacent to the existing newsroom. Here the live remote broadcasts are set up, coordination with the remote sites is checked and verified, and each remote signal is assigned to one of an array of frame synchronizers. The new frame synchronizer arrangement allows simultaneous delay of audio and video, which helps avoid lip sync problems. Multiple remote signals can be managed via frame synchronizers embedded in dedicated A-D converters. Analog signals not converted directly to SDI are available via tie lines, which connect the analog routing environment into the digital environment via A/D converters. Within the SDI environment, audio is embedded.

A major challenge was building a new production room while simultaneously producing six hours of live news.

Difficulties faced

A major challenge was building a new production room within the space occupied by existing production room facilities, while simultaneously producing six hours of live news. The build-out had to occur without impacting news operations. This required careful planning and coordination, as well as open lines of communication.

Furthermore, the design needed to provide ready access to the associate producer and the CG operator without disturbing the remaining functions of the room. Additionally, the audio operator, executive producer and CG operator needed to be on an elevated platform behind the video production furniture where they could enjoy clear views of the monitor wall.

The design accomplished station objectives, although a major structural element that partially obscured the CG operator's view of the monitor wall required a change of plans. Because the CG operator has close-in monitoring of key signals, KCNC considered this to be acceptable.

The most difficult part of the project was rearranging the racks and equipment in the rack room. This required close coordination between Burst and station engineering personnel. The old racks were emptied and removed. Then, new racks were installed and electrical power was connected.

Because the old switcher was still in operation at the time it was moved, this required careful scheduling. Adequate time was needed to shut it down, disconnect the wiring, move the switcher and its support equipment, reconnect the wires, bring the equipment back online, test it and troubleshoot any difficulties. Additional equipment moves involved a Chyron Duet; an Aprisa 300 clip server, SSX still store and VCS video clip server; and an Accom DVEous retrofitted for SDI.

In the process of reassigning equipment to racks, Burst completed a rack heat and power study that optimized the use of rack spaces to avoid heat problems and assure adequate electrical power and HVAC.

Besides learning a new switcher, the operators were faced with two other important challenges. As is so often the case, a room's size, shape and access will dictate the placement and functionality of the room. The situation here was no exception.

In the old production control room, the TD sat to the left of the director, who sat to the left of the producer, who sat to the left of the associate producer. In the new space, the room dictated the arrangement to be exactly opposite. This meant that people accustomed to looking to their right for visual cues would be looking to their left instead.

The second challenge was becoming accustomed to monitoring on virtual monitor walls instead of glass monitors. Because the operators were accustomed to the look and feel of glass monitors, the new environment took a little getting used to.

The end result

The transition from the old facility to the new one was not without its hiccups, but they were minor. Communication between the station's engineering staff and Burst was excellent. This, combined with an established and positive working relationship with the interior designer and general contractor, resulted in a successful project. KCNC is proud of its HD-ready control room, which is now delivering clean newscasts and live programs. BE

Tom Norman, CPBE, is a senior project manager with Burst.

Design team

Burst
- Scott Barella, vp engineering
- Tom Norman, sr. engineer
- Brent Bullock, sr. sales executive
- Letha Koepp, admin. project mgr.
- David Gertner, lead installer
- Marc Anisimow, installer
- Jason Meisenberg, installer
- Danny Rowland, installer
- Doug Kanczuzewski, furniture

KCNC-TV
- David Layne, dir. op., engineering
- Pat Brus, mgr. engineering
- Mike Blake, engineer
- Collette Calvert, technical dir.
- David Harder, technical dir.

Technology at work

Accom DVEous
ADC PPI2232RS-MVJ patch panel
Belden 1695A cable
Chyron
- Duet
- Aprisa
- 300 clip server
- SSX still store
- VCS video clip server

Clarity Lion rear projection displays
Evertz
- 500AMDA/VMDA DA/converter
- 7720ADC-A4 Audio A-D
- 7735CDM/CEM converters
- 7736CDM/CEM converters
- 7745FS-EAES frame sync

Gefen DVI fiber extenders
High Tech Furnishings desks
Miranda Kaleido K2 processors
Sony MVS-8000 switcher
Wohler RM-2440 Quad LCD monitor

File formats

Here's an overview of the material chain and the resulting file format implications.

BY BOB EDGE

Audio and video material goes through many steps as it moves from a camera to a TV receiver and archives. The following is an overview of parts of a broadcaster's material chain and the resulting file format implications.

Acquisition and contribution

When material is captured as part of the program production cycle, quality is key. Metadata support that identifies shot and take information, shooting location, timing and links to the script will improve production efficiency. In news acquisition, capturing the "who, what, when, where, why and how" information during shooting can improve the access to this source material in later phases of production.

Sports programs combine both on-site and recorded segments. These live events require substantial facilities, planning and crews. While sports events are planned, news events typically are not, except for news conferences. Common elements with these two types of programming include the need to manage latency, have reasonable quality and perform real-time effects. This usually requires an uncompressed routing and signal processing system.

Post production is a different world. A large collection of material is combined in an artistic effort.

On-air operations

The day-to-day operation of a broadcast facility presents a different set of requirements. What is important to one part of the process may be irrelevant to another. Most of the rich editing and material production metadata needed for production and post production are not needed in the finished material.

However, metadata about ownership, content usage and related information are useful. An on-air operation needs access to program content with latencies of perhaps a few seconds. Cuts-only video edits, audio fade in/out and voice-overs are used for last-minute content changes.

Post production

A post-production house can benefit from a file format that can save work in process. Re-edits are simplified so one can easily undo editing that did not gain a customer's approval. While stream formats can be used to import and store material in these systems, a richer format is needed to maintain the source material in a form that permits effective editing.

A typical post system stores the metadata and an Edit Decision List (EDL) in a database. This means that post-production systems need to support rich editing models. The objective is to have fast, simple and effective editing. A final program, commercial or other content is made by compiling or conforming to a streaming format. This step creates a finished version for distribution that does not contain the EDL, the unused audio/video material, and most of the production and editing metadata.

Archives

Each facility will impose different requirements on its archives. Let's

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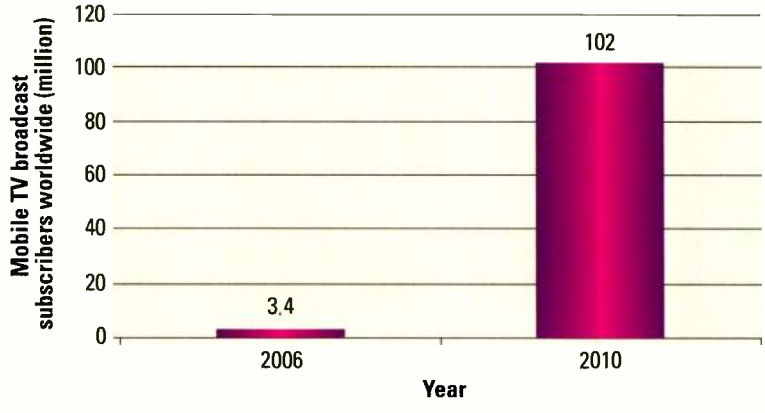

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review some of the important file format requirements.

When a project is in post production, it may be desirable to save a copy of the work in process. This simplifies later production of derived works.

An archive supporting the storage of a master program editing version needs rich metadata and the source material referenced by the EDL.

Short-term archives are desirable for the production of news and sports. These frequently have all of the material captured from inbound feeds and other material acquired by an organization. This material may be kept for several days to a few weeks. A fraction of the material is sent to a long-term archive.

A broadcaster may wish to save copies of the final version of the actual broadcast. The metadata needed with the material are limited. Most archival metadata will probably be kept in a database for fast access.

At CNBC, a Grass Valley NewsBrowse Web-based browser/editor manages a file-based news system.

A single format

Unfortunately, fundamental conflicts make it difficult to build a single format that meets these diverse requirements. For example, if a file is stored as audio or video tracks, an NLE can work with it quickly and effectively. A compilation turns the tracks into low-latency time-multiplexed streams that are ready for playout. Part of the stream compilation is the rendering of dissolves and other transitions. Filtering the metadata is also accomplished during the compile process.

Minimizing the number of formats a broadcaster uses will greatly simplify what the operators have to do and improve their workflow efficiency. However, selecting a single format that does not work well over the complete material chain produces the opposite result. Stream and file formats should match the workflow.

Compressed formats such as DV DIF and MPEG elementary streams are well suited for the transport and emission of uncut works. MXF supports a wide variety of video compression systems and rich metadata. The focus of the MXF architecture is material interchange between devices. It can also be used on the disk as a storage file format in some applications.

For editing systems, fast and effective editing is the highest priority. The AAF Association has delivered a file format, an API specification and sample software. AAF is an evolution of the OMF project. It has been adopted by several vendors and is currently being standardized by SMPTE. The format supports a wide range of features needed for post production.

Formats that support simple edits and have low latency remain the best solution for news, sports and on-air operations.

Audio and video are important parts of today's personal computers. Microsoft, Apple, RealNetworks and others have developed formats and tool sets to support audio and video on PCs.

The feature sets in these formats focus on desktop computing, not broadcasting. However, because the personal computer market is large, a significant number of applications are available. This means that in some broadcast applications, prosumer PC solutions may be the proper choice.

Conclusions

The number of features any stream or file format provides varies. As designers try to solve more problems with a single format, the complexity increases dramatically. Sometimes designers are able to invent simple solutions to complex problems. Unfortunately, this is not always the case.

Formats that support simple edits and have low latency remain the best solutions for news, sports and on-air operations. Such formats are not appropriate for post production or high-end editing applications.

End users should select a format that is supported by the devices they wish to install and matches their workflow requirements. Users may find that tomorrow's devices will support multiple formats, thereby giving operators the best of many options. BE

Bob Edge is manager, standards and technolgoy, Thomson Grass Valley.

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News is now shot for TV, Internet and cell phones. This demands a camera that is easy to integrate into the production workflow. Photo courtesy AP Images.

The camera becomes a means to an end

BY MICHAEL GROTTICELLI

These days, when looking to buy a broadcast ENG camera, the key purchasing issues for broadcasters revolve around how the images will be used once they leave the camera. That is, how they fit into a high efficiency, minimal labor, news production workflow.

On the list of desirable camera features, scanning method, digital signal processing and low-light sensitivity appear to have become secondary concerns to how the images are stored and output from the camera.

This is true for both tapeless and tape-based acquisition systems, both of which rely on proprietary compression formats. Indeed, new technology developments in imagers (both traditional CCD- and CMOS-equipped models), data transfer rates (25Mb/s, 75Mb/s and 100Mb/s for HD alone) and removable recording media are getting a lot of press. But in the scheme of the news production chain, when it comes to making purchase decisions, stations often now look at the camera as simply a means to an end.

When it comes to making purchase decisions, stations often now look at the camera as simply a means to an end.

While many news departments are aggressively moving to tapeless operation in all aspects of the production process, videotape still plays a major role in electronic newsgathering, both in SD and HD. In tandem with this move away from tape, the emergence of the highly affordable HDV (25Mb/s) format has allowed stations to acquire local news in 1080i or 720p HD. They could never afford to do this otherwise, so the use of tape is still a practical alternative.

Every station has a different way it

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Using new tapeless technology, like Panasonic's SPX800 P2 solid-state camcorder, stations like KRGV-TV, in Weslaco, TX, are moving from a tape-based workflow to quick turnaround news production.

likes to work, based perhaps on multi-client browsing, the NLE system in use and the various steps the program goes through before being broadcast to air. Therefore, when buying a camera, the goal is to choose a model that allows the crew to move material through a station's news production infrastructure faster, while maintaining the highest possible image quality within the set limits.

The ideal camera, be it SD or HD, should somehow improve the existing production process and be compatible with the way your staff likes to operate (e.g., proxy files, Long GOP files, compression methods) and the NLE system they use. Some cameras require the user to transcode the IT-centric file captured with the camera to baseband video before you can begin editing. Others create a proxy (clone) of an MPEG-compressed file, allowing you to start working immediately.

This new way of looking at broadcast cameras is because the digital processing circuitry in general has gotten so good that users can count on most models to produce images that are crystal clear and can make any on-screen newscast shine — especially when compared to analog cameras of the past. (There are still some network divisions and local stations using Betacam SP and, gulp!, M-II.) Price and feature sets are the big differentiators, with new broadcast production-style models now costing from approximately $5000 to $65,000.

In introducing new, lighter models with smaller sized CCDs (going from 2/3in to 1/2in), camera vendors have strived to offer more features at lower costs. This year's NAB saw the emergence of the sub-$25,000 high-definition 2/3in and 1/2in camcorders for news, something unheard of even three years ago. There were also sub-$6000 HD 1/2in and 1/3in cameras that capture in SD as well.

As stations continue to control expenses, camera manufacturers are attempting to spread their R&D investments by simultaneously offering products that address the high and low ends of the production spectrum. Consumer divisions now help market and sell to broadcast customers.

Creatively, the lines are blurring as small-format HDV cameras are increasingly being used in tandem with larger format models on the same production. It's happening more often at both the network and local level.

The less expensive cameras may

Canada's CHUM Television network has purchased 49 Ikegami EditCam3 camcorders, which interface directly to its Avid NewsCutter NLE systems.

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The 24-hour New England Cable News channel is using Sony XDCAM camcorders in tandem with Grass Valley NewsEdit NLE systems to stay competitive.

use smaller CCD imagers, operate at 25Mb/s or provide fewer operator features. Some news and technical directors say this limits the final HD image quality by providing less color space and image/lighting latitude.

However, it appears that many stations, even those doing their local newscasts in HD, are willing to accept these limitations in order to meet budget demands. Stations often use higher end cameras in the studio but still settle for unconverted 50Mb/s SD images from the field. This may not be a perfect HD solution, but it does improve a station's on-screen look and helps it stay competitive. And, we're still at the stage where most viewers won't notice the difference.

Consider the workflow first

As anyone who's worked in news will tell you, at the end of the day, it's all about who gets the big story to air first. That's why a variety of tapeless camera systems are beginning to flourish. Sony's Bob Ott, vice president of the optical and network product marketing division, said recent camera sales have become less about image quality and more about how fast the operator can get the images out of the camera and into an edit system. Although, many operators say the pictures sell the camera, especially among network-level purchases.

Bruce Cowan, director of broadcast technology and operations at Canada's CHUM Television network, said moving from a tape-based workflow to a tapeless workflow was the main motivation behind the decision to purchase 49 Ikegami Editcam3 camcorders. These cameras, with removable FieldPaks, are being distributed among its Toronto, Vancouver and Alberta news bureaus.

Cowan said the Editcam's FieldPaks interface directly to CHUM's Avid NewsCutter NLE systems (with Avid's ISIS storage), thus it eliminates the time-consuming need to copy or transcode raw material into the system. The FieldPaks provide more than two hours of record time and use standard laptop disc drives (internal to the FieldPak), which, he said, are key to fast news turnaround. CHUM plans to install Sony HDC-F950 HD cameras in the studio.

Most of today's SD and HD cameras offer 4X to 6X transfer speeds via FireWire connections. They are equipped with removable hard drives, a solid-state Flash memory card or optical discs and are adept at moving data from the camera to an NLE system. Grass Valley's recently released REV PRO cartridges are recognized by many computer editing systems as just another file on the desktop (or in the timeline).

Lots of choices

JVC's GY-HD100U 720p HDV camcorder has been popular with broadcasters looking to move to HD cost-effectively. And it's not only at the local level. In November, using the HD100U, ABC's national "Good Morning America" (GMA) became the first regularly scheduled network news program broadcast in HD. The JVC camera captures the opening exterior shot of GMA's Times Square headquarters, as well as POV images that are regularly intercut with the show's HD studio feed.

With the introduction of JVC's HZ-CA13U 16mm film lens adapter, the GY-HD200U can accept a variety of stock prime and zoom lenses. The camera also has an Image Inversion function, which allows for the compensation of picture reversal created by prime lenses so that special editing functionality is not required for correct recording of the image. JVC will soon deliver a second HDV camera, the GY-HD200U, which is designed specifically for ENG applications and will include a 60p encoder as well as enhanced gamma and genlock features.

Regarding tapeless ENG acquisition, Ikegami offers 80GB and 120GB FieldPaks for its HDN-X10 Editcam HD and DNS-33W SD Editcam3 camcorders. The 120GB FieldPak costs $750 and records 90 minutes of 145Mb/s HD video or nine hours of 25Mb/s SD video. The company also announced a 16GB RAMPak solid-state Flash memory that will sell for less than $1500. The 16GB RAMPak can hold more than 70 minutes of DV25 video.

Hitachi offers new Mediapac cartridges for its Z-DR1 solid-state hard drive recorder, which docks to the company's Z-4000W SD camera for ENG use. The cartridges come in 8GB and 16GB versions, and soon a 160GB hard-disc storage drive will be available. At this point, the system accommodates only SD production, but, as Emilio Aleman, product manager at Hitachi, will tell you, there's still an awful lot of SD production being done. Although HD production is growing, SD production will be around for a long time to come.

The Mediapacs are aluminum-encased Hitachi hard discs, ranging between 40GB and 120GB capacity, which offer up to nine hours of recording time per Mediapac.

Panasonic has gained considerable traction with its DVCPRO P2 solid-state recording system, including large purchase orders from Raycom Media (21 stations), Nexstar Broadcasting Group (26 markets) and Media General (20 stations). The solid-state PCMCIA P2 card is available on several of its new DVCPRO cameras, including the AG-HVX200 HD (1/3in CCDs) and new AJ-SPX800 (2/3in, 24p) SD camera. At NAB, the company also showed the new tape-based AJ-HDX-900 HD camera.

As Panasonic predicted, the price of solid-state storage has begun to drop. Last year, a 4GB card cost about $1400. Today that same card goes for $550. The Secure Digital P2 memory cards provide approximately 35 minutes of DVCPRO 50 recording on a 4GB PCMCIA card. Plus, a variety of frame rates can be stored on a single P2 card. Panasonic says most customers purchase about five cards per camera.

Sony's XDCAM optical discs have also been embraced by a wide range of broadcasters, including the CBS News division and all 16 network O&Os, several Gannett stations and Cablevision's News 12 (in New York). The Sony XDCAM HD family of optical products includes two camcorders with varying features. The CBS deal was announced at NAB, but as of press time, the cameras remain undelivered because of a lack of 1/2in lenses. Both Canon and Fujinon unveiled such lenses at the NAB convention this year. The lenses can be used either in the studio or in the field and are specifically tailored to ENG and location production.

Following Sony's ongoing camera strategy of legacy compatibility, the same Professional Disc media used in the SD version of the XDCAM system also works with the new HD version. Users can record up to two hours of HD content on a single 23.3GB optical disc, with a data transfer rate of 72Mb/s (per optical head).

Grass Valley's new Infinity series HD camcorder has 2/3in lenses and a wealth of storage options, but the camera has yet to be delivered. (Two stations in the United States are said to be beta testing it.) The camera, which has shaken up the industry in terms of price and performance potential, uses the Grass Valley 35GB REV PRO cartridge (manufactured by Iomega) as its primary storage device, but users also have the ability to record to solid-state (SanDisk) and USB storage as well. The highly flexible camera also offers a choice of MPEG-2 or JPEG2000 compression recording.

Plenty of good solutions

With the need to produce images for an increasing variety of platforms (e.g., TV, Internet, handheld devices), the camera, which was once viewed as a separate tool, is now seen as part of an overall system purchase order. The variety of choices now available allow stations to select the model, compression and recording format that best fits their needs. BE

Michael Grotticelli regularly reports on the professional video and broadcast technology industries.

Today's broadcast facilities increasingly rely on IP routing technology. Photo by Andy Washnik, CORPICOM.

SPECIAL REPORT:

Understanding IP ROUTERS

BY CIPRIAN POPOVICIU

Internet Protocol (IP) has emerged over the past decade as the most deployed data communications transport protocol. To a certain extent, IP's unanimous adoption is due to its simple nature and open standards development. However, the main reason for its unforeseen success is its packet-based and connectionless mode of operation.

With IP, data of any type is placed inside a packet, which is stamped with a destination and a source address. The packet is then left at the mercy of an IP network, which is supposed to somehow get it to its destination.

IP networks represent a collection of devices that have the sole purpose of moving packets from the source to the destination. (See Figure 1.) These highly customized computing devices are called IP routers, and they are interconnected via multiple links that terminate on their interfaces. There are two primary operational planes for a router. The control plane creates and maintains a map that allows the router to make the best forwarding decisions. The data plane forwards IP packets from the ingress to the egress interface.

Control plane — routing

All routers in an IP network must collaborate in order to make sure that each one of them is capable of identifying the best paths and the best backup paths to reach the destinations. In order to perform this function, routers will communicate with their neighbors or routers from an entire domain of the network, exchanging relevant information regarding the state of the network and the reachability of each IP address. Based on this information, each router calculates the best path to all known IP destinations. IP routing protocols identify the mechanism by which routers communicate with each other and the algorithm used to calculate the best routes.

There are multiple routing protocols defined for IP. Those used within an area of the network or an administrative domain are called Interior Gateway Protocols (IGPs). Examples of IGPs include Routing Information Protocol (RIP), InterGateway Routing Protocol (IGRP), Enhanced InterGateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (ISIS).

The routing protocols used to route between domains or networks are called Exterior Gateway Protocols (EGPs). The representative example of EGP is Border Gateway Protocol (BGP).

The IGPs are also classified based

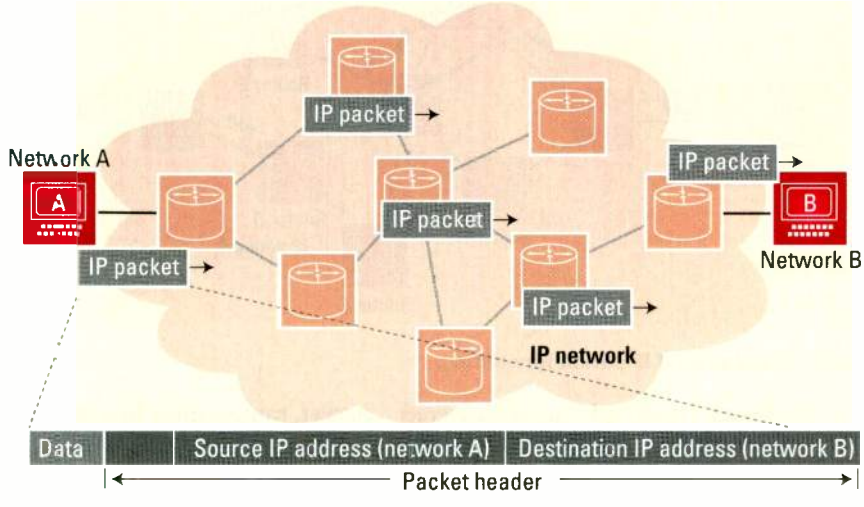

Figure 1. The connectionless and packet-based forwarding nature of IP communications relies on IP routers.

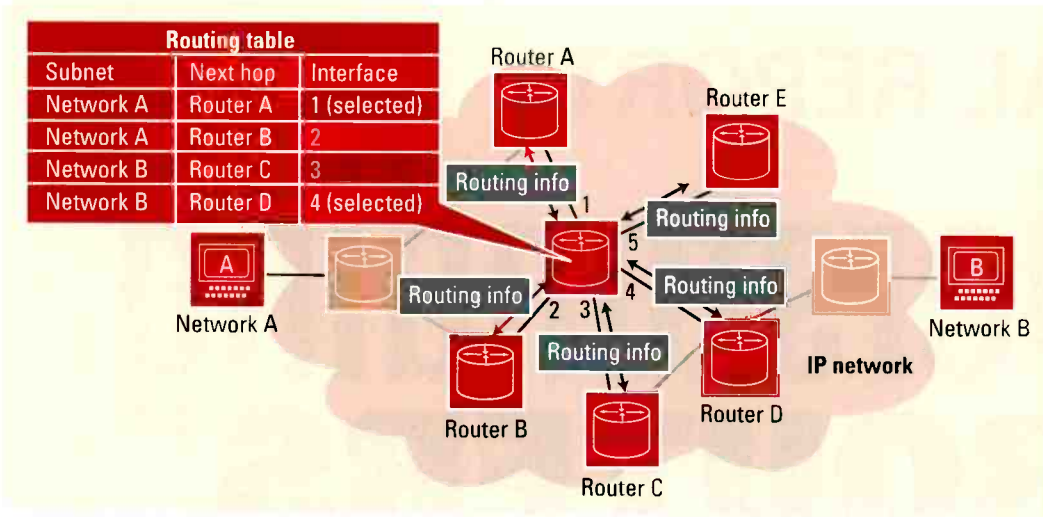

Figure 2. A routing table dynamically maintains the address of a packet's next hop.

on their principle of operation. OSPF and ISIS are called link-state protocols, and they maintain a view or state of the entire network. RIP, IGRP and EIGRP are called distance-vector protocols, and they rely on their neighbors to make routing decisions. Each routing protocol has its own benefits and deficiencies, and each is best suited for a certain network environment.

The outcome is a routing table indicating what next hop a packet needs to be sent to in order to be delivered optimally to a particular IP address or to reach destinations within an IP subnet. (See Figure 2.) This data is dynamically maintained. If a path becomes impaired or nonoptimal, the routing protocol will update the routing table.

Data plane — forwarding

A router has multiple interfaces, often of different media types such as Ethernet, Packet Over SONET (POS), Asynchronous Transfer Mode (ATM) and Integrated Services Digital Network (ISDN), etc. IP packets are delivered to an interface encapsulated in an envelope specific to that interface type.

In the process of forwarding the packet, routers must first unwrap the media-specific information, analyze the header for integrity, if necessary, and extract the relevant IP information, primarily the destination IP address. The router will then use the knowledge learned via the control plane (the routing table, which is mapped into a forwarding table) to switch the IP packet to the interface identified for the optimal path. The packet is then wrapped up in the frame specific to that interface's media type, and it is sent to the neighboring router.

The basic concepts of the forwarding process are presented in Figure 3. In reality, some parameters of the IP packet itself will have to be slightly manipulated in the process of switching, in which case the packet must be rewritten before it is encapsulated into the media-specific frame. While a centralized CPU performs the control plane functions, a CPU can do the data plane forwarding, or it can be done with the help of dedicated hardware.

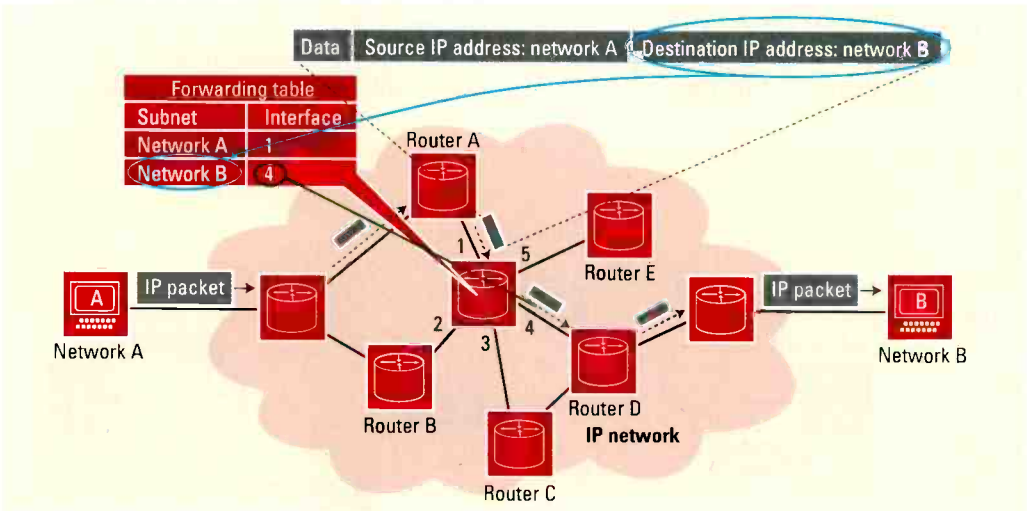

Figure 3. An example of IP packet forwarding.

Router architecture

With the rapid adoption of IP, more is required of IP networks and IP routers. Large amounts of traffic must be switched with minimal packet loss, and time-sensitive applications require packet delivery with minimal delay and jitter. These requirements demand high-performance router architectures that leverage powerful processors or the implementation of forwarding functions into hardware. Figure 4 on page 66 compares software and hardware router architectures.

A router's position within the network dictates its required capabilities. Core routers must forward large amounts of traffic, a capability that can be implemented in hardware, while edge routers must support a rich set of features and functions that might not be suited for full hardware implementations.

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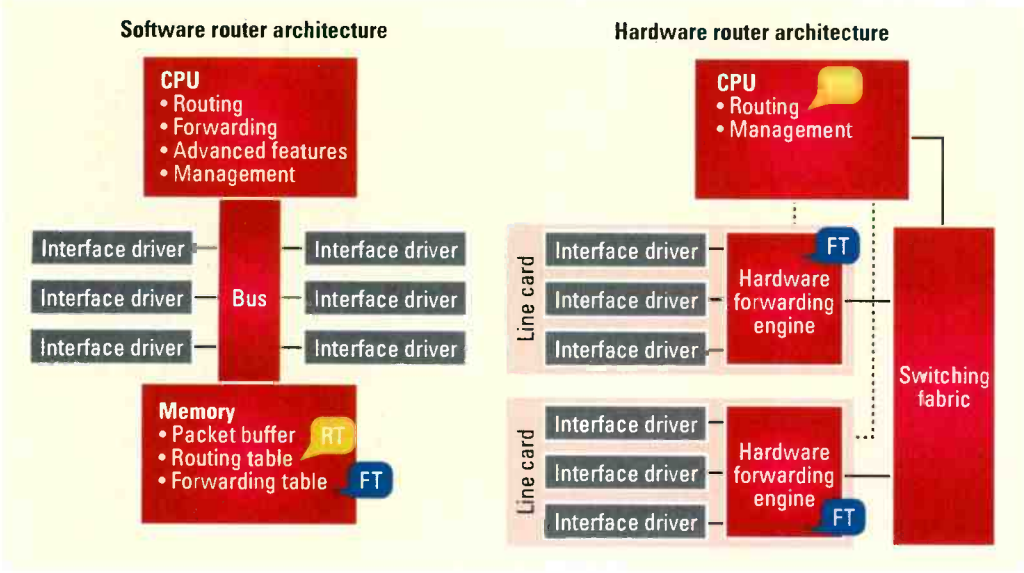


Figure 4. There are two basic types of router designs; those that are software-based and those that are hardware-based.

Their price and flexibility ultimately dictates the router selection for specific roles within a network.

Advanced router features

IP has outgrown its original scope of simply transporting data between two end points. It is now used to deliver a wide variety of services, each service requiring advanced functionalities and feature support by the IP routers. For example:

• Voice, audio and video services require a certain QoS to be enforced. Thus, routers support a set of congestion avoidance, congestion management and resource management mechanisms that enable them to treat IP packets based on the service requirements.

• Content delivery and collaborative services are supported in a scalable manner by enabling the IP networks and their routers to optimally multicast packets from a source to a set of listeners.

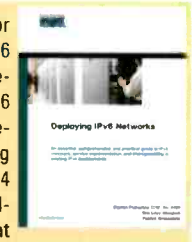
• Traffic control and security concerns require routers to be capable of filtering traffic based on certain parameters and to make more complex forwarding decisions than simply looking up the packet destination address in the forwarding table.

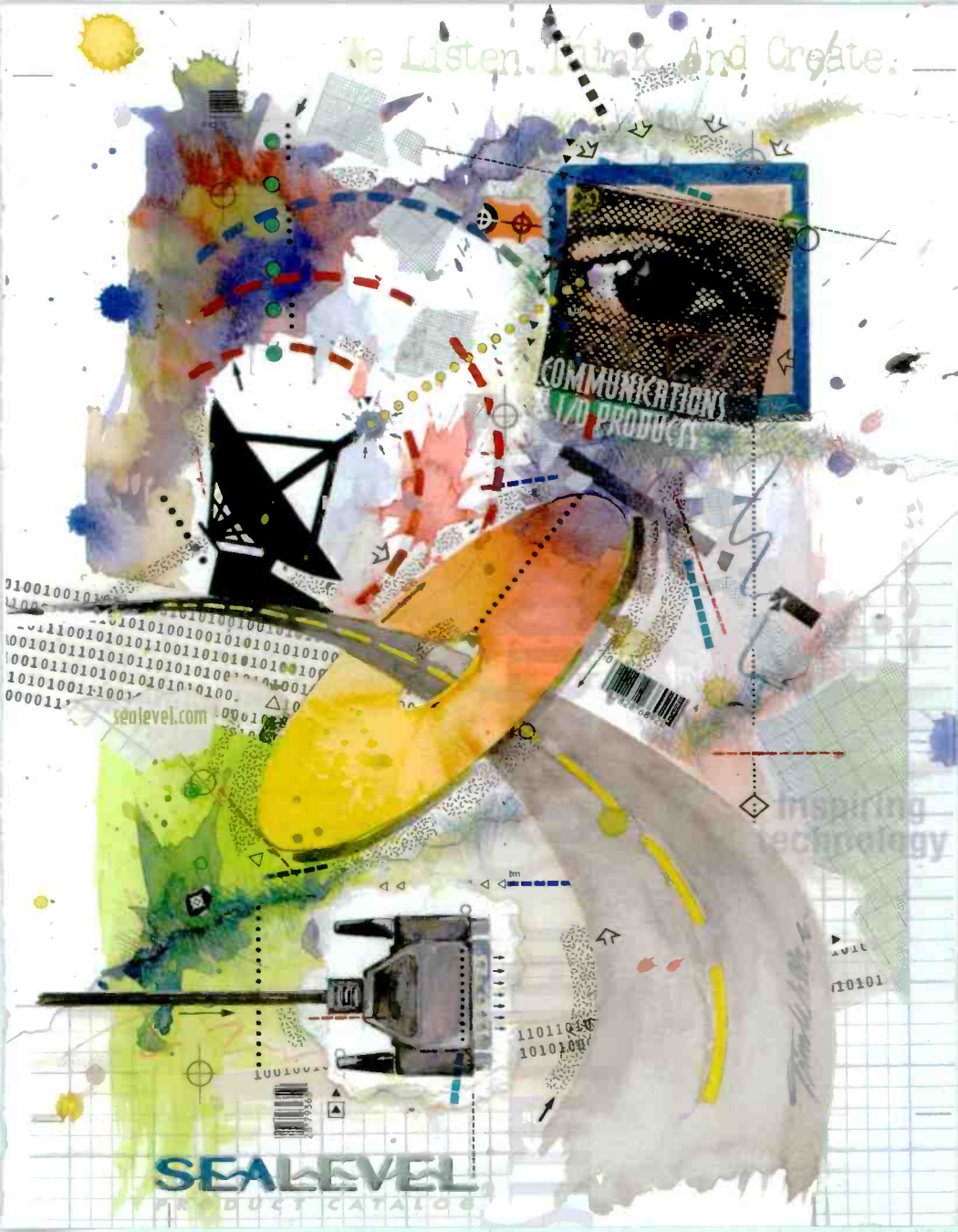
• The operation of today's networks requires routers to support various additional control and management protocols.

These functions — some integrated in hardware while others handled exclusively by the CPU — stand witness to the extraordinary evolution of the IP router from its original, basic IP switching role to its current critical role in supporting complex services. BE

Ciprian Popoviciu, PhD, CCIE, is a technical leader within the Networked Solutions Integration Test Engineering (NSITE) group at Cisco Systems.

Ciprian is an author of "Deploying IPv6 Networks," a comprehensive guide to IPv6 concepts, service implementation and existing interoperability in IPv4 environments. It's available from Cisco Press at www.ciscopress.com/title/1587052105.




COMMUNICATIONS
I/O PRODUCTS
sealevel.com
SEALEVEL
PRODUCT CATALOG

SEALEVEL

We've been listening, thinking, and creating for almost 20 years.

Dear Colleague,

Thank you for your interest in Sealevel Systems. Since 1986, our mission has been to develop the most innovative, reliable I/O solutions available. These past 20 years have seen much growth and opportunity for Sealevel Systems. The relationships and confidence we have built and earned is obvious in everything we do, from a 10-year-old ISA card (now RoHS compliant!) to our new modular PC and I/O "building blocks". Watch for more neat products in these areas

If you are already a Sealevel customer, I thank you. If not, I invite you to try our quality, service, and support. Thanks again.

Sincerely,

Tom O'Hanlan

864.843.4343

www.sealevel.com sales@sealevel.com

About Sealevel Systems, Inc

Since 1986, Sealevel Systems has manufactured serial and digital I/O products recognized as best in class by top commercial, military, and aerospace companies. Thanks to our loyal customers, 2005 marked Sealevel's most successful year. To allow for continued growth and to accommodate you better, we've just moved into a new 45,000 square foot facility on a 17-acre site in Liberty, SC.

Over the last year, we've been busy designing a number of new products. We currently manufacture over 250 standard I/O devices enabling interface to your host system via Ethernet, USB, or a variety of bus types including PCI, PC/104, and PCMCIA. At the system level, the Relio™ family of solid-state embedded I/O servers elevates industrial computing to new degrees of expandability and reliability. Please visit www.sealevel.com for details, technical documentation, application examples, and a complete listing of accessories.

Technical Support

Our experienced staff of application engineers provides the best assistance available. Call us before you order for help selecting the right product or after the sale for answers to your hardware or software questions. Knowledgeable, friendly technical support is available Monday through Friday from 8am to 5pm EST.

Lifetime Warranty

We are so confident that our I/O products will give you the dependability you expect that we extend an industry-leading Lifetime Warranty. If any Sealevel I/O product fails during normal use, simply contact us for fast repair or replacement.

RoHS/WEEE Compliance & Green Initiatives

Sealevel Systems is committed to providing our customers reliable products that comply with RoHS (2002/95/EC), WEEE (2002/96/EC), and other green initiatives being adopted by the global community. The RoHS directive restricts the use of lead and certain other hazardous materials in electronic products marketed to the European Union. Sealevel is designing all new products for RoHS compatibility as well as modifying legacy products and manufacturing processes for RoHS compliance. We will continue to offer **both** RoHS compliant and non-compliant products to meet global and domestic customer demand. Please call us or visit our website for up-to-date information.

> The Earth was not given to us by our parents, it is loaned to us by our children.
>
> - Proverb

Custom Product Design

Some of our best new product ideas come from our customers. Sealevel's talented team of hardware and software engineers can take custom designs from inception to production in as little as six weeks. Call us today with your custom requirements. We'll Listen. Think. And Create.

Serial I/O

Ethernet

Connect with confidence. SeaLINK Ethernet serial servers offer the easiest way to network enable RS-232, RS-422, and RS-485 serial devices. Powered by a 32-bit embedded microprocessor, SeaLINK products reliably communicate over multiple ports at sustained rates up to 230K bps. All SeaLINK devices use industry-standard TCP/IP protocol (RFC-2217) and allow any host to access serial ports as virtual COM ports. Serial tunneling is also supported, allowing two native serial devices to communicate over a network.

One & Two-Port Ethernet Serial Servers

Mount compact single and dual-port SeaLINK products almost anywhere to access serial peripherals from your network. The popular, optically isolated 4103 includes an isolated digital input and Reed relay output to enable remote monitoring and control capabilities.

All Ethernet serial servers include:
- Power supply
- Ethernet patch cable
- Crossover cable
- Serial loopback
- QuickStart guide

Additional accessories are available at www.sealevel.com.

One & Two-Port Ethernet Serial Servers						
Item#	Ports	RS-232	RS-422	RS-485	Isolated	Price
4101	1	•				$189
4102	1		•	•		$199
4103	1	•	•	•	•	$299
4104	1	•	•	•		$209
4201	2	•				$349
4202	2		•	•		$369
4203	2	•	•	•		$389

Four, Eight, & Sixteen-Port Ethernet Serial Servers					
Item#	Ports	RS-232	RS-422	RS-485	Price
4401	4	•			$499
4402	4		•	•	$549
4403	4	•	•	•	$569
4801	8	•			$699
4802	8		•	•	$749
4803	8	•	•	•	$799
4161	16	•			$999
4162	16		•	•	$1049
4163	16	•	•	•	$1099

Four, Eight, & Sixteen-Port Ethernet Serial Servers

Boasting fast throughput and flexible configuration, SeaLINK multiport Ethernet serial servers allow connection of up to 16 serial devices to a network. Four and eight-port models are designed for table or DIN rail mounting, while 16-port products are 1U, 19" rackmount compatible.

Serial I/O

USB

USB is ubiquitous. Take advantage with SeaLINK USB serial adapters. Whether you require one serial port or sixteen, SeaLINK USB devices will have you quickly communicating with RS-232, RS-422, and RS-485 peripherals. Unlike traditional UART-based devices, SeaLINK USB products use a state-machine architecture that reduces host processor overhead for faster, more reliable communications.

One & Two-Port USB Serial Adapters

SeaLINK USB devices are the easiest, most reliable way to add serial ports to a PC. The 2106 integrates a six-foot cable and is ruggedized for use in industrial or marine environments. The 2108 and 2208 connect to standard USB header connectors found on most motherboards and mount in any available PC slot. All single and dual-port SeaLINK devices are powered by the USB connection.

One & Two-Port USB Serial Adapters

Item#	Ports	RS-232	RS-422	RS-485	Isolated	USB Powered	Connector	Price
2101	1	•				•	DB-25M	$89
2102	1		•	•		•	DB-25M	$129
2103	1	•			•	•	DB-25M	$129
2104	1		•	•	•	•	DB-25M	$139
2105	1	•				•	DB-9M	$79
2106	1		•			•	DB-9M	$109
2108	1	•				•	DB-9M	$69
2201	2	•				•	DB-9M	$159
2202	2		•	•		•	DB-9M	$189
2203	2	•	•	•		•	DB-9M	$229
2208	2	•				•	DB-9M	$129

Four, Eight, and Sixteen-Port USB Serial Adapters

Designed for quick field installation, multiport SeaLINK USB products offer fast, reliable RS-232, RS-422, and RS-485 communications. Sixteen-port devices include two convenient USB 1.1 downstream connections to allow daisy chaining SeaLINK USB devices or interfacing standard USB peripherals. Each port on the 2167 is individually configurable for RS-232 or RS-485 by simply selecting the appropriate cable pinout.

Four, Eight, & Sixteen-Port USB Adapters

Item#	Ports	RS-232	RS-422	RS-485	USB Powered	Connector	Price
2401	4	•			•	DB-9M	$209
2402	4		•	•	•	DB-9M	$239
2403	4	•	•	•	•	DB-9M	$279
2801	8	•			•	DB-9M	$399
2802	8		•	•	•	DB-9M	$449
2803	8	•	•	•	•	DB-9M	$499
2161	16	•				RJ-45	$729
2167	16	•		•		RJ-45	$799

Easily customize serial wiring connections using DB9, DB25, RJ45, and screw terminal accessories. Visit www.sealevel.com for details.

In 1994, Sealevel invented the RS-485 'auto-enable' circuit that automatically handles RS-485 driver enable. Many competing products use inferior methods of RS-485 control, including a 'one-shot' circuit, that limits data rates and can result in data loss. Boards with the Sealevel 'auto-enable' circuit are compatible with standard COM drivers and can be utilized for RS-485 communications at virtually any baud rate and word length.

Serial I/O

PCI

Still going strong. Sealevel's PCI bus serial boards offer the widest choice of I/O connectivity available. Options include RS-232, RS-422/485, and RS-232/422/485 multi-interface boards. Choose from low profile or standard PCI form factors as well as universal bus (3.3V and 5V) versions compatible with new and legacy computer systems. Enhanced UART options are available that support custom baud rates and 9-bit protocol. A variety of cabling and termination accessories simplify installation, and Sealevel's commitment to long-term availability guarantees the board you design in today will be available and supported for years to come.

Low Profile PCI
RS-232

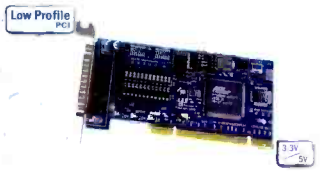
Ports	1
Item #	7104
Price	$109

- 16C850 buffered UART with 128-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- DB-9M connector

Low Profile PCI
RS-422/485

Ports	1
Item #	7107
Price	$129

- Configurable for RS-422 or RS-485
- 16C950 buffered UART with 128-byte FIFOs
- Data rates to 921.6K bps
- Accepts +5/+12VDC and passes voltage through on connector pin 9
- DB-9M connector



Low Profile PCI
RS-232/422/485

Ports	1
Item #	7106
Price	$169

- Configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- 16C850 buffered UART with 128-byte FIFOs
- Data rates to 460.8K bps
- DB-25M connector

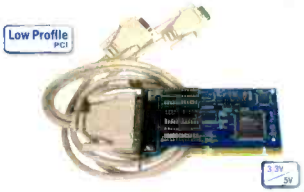
Low Profile PCI
Isolated RS-232/422/485

Ports	1
Item #	7108
Price	$229

- Configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- Optical isolation provides protection against transients and ground loops
- 16C850 buffered UART with 128-byte FIFOs
- Data rates to 921.6K bps
- DB-25M connector

3.3V 5V denotes universal bus PCI compatible with 3.3V & 5V systems

864.843.4343
www.sealevel.com sales@sealevel.com



Low Profile PCI
RS-232/422/485

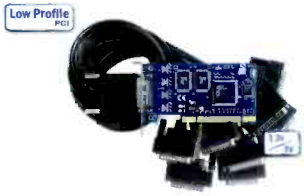
Ports	2
Item #	7205
Price	$209

- Each port individually configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- 16C850 buffered UARTs with 128-byte FIFOs
- Data rates to 460.8K bps
- 36" cable terminates to two DB-9M connectors

Low Profile PCI
RS-232

Ports	4
Item #	7406-DB9
Price	$229

- 16C854 buffered UART with 128-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- 36" cable terminates to four DB-9M connectors
- Available with DB-25M fan-out cable



Low Profile PCI
RS-232

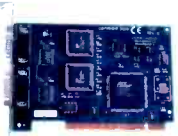
Ports	8
Item #	7803
Price	$399

- 16C864 buffered UARTs with 128-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- 36" cable terminates to eight DB-25M connectors
- Available with DB-9M fan-out cable

PCI
Isolated RS-232/422/485

Ports	1
Item #	7103
Price	$229

- Configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- Optical isolation provides protection against transients and ground loops
- 16C850 buffered UART with 128-byte FIFOs
- Data rates to 460.8K bps
- DB-25M connector



PCI
RS-232

Ports	2
Item #	7202
Price	$129

- 16C550 buffered UARTs with 16-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- Two DB-9M connectors

PCI
RS-422/485

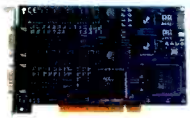
Ports	2
Item #	7204
Price	$189

- Each port individually configurable for RS-422 or RS-485
- RS-485 auto-enable circuit
- 16C550 buffered UARTs with 16-byte FIFOs
- Data rates to 460.8K bps
- Two DB-9M connectors

PCI
RS-232/422/485

Ports	2
Item #	7201
Price	$209

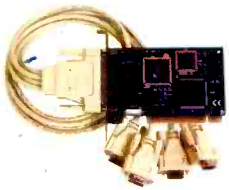
- Each port individually configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- 16C850 buffered UARTs with 128-byte FIFOs
- Data rates to 460.8K bps
- Two DB-9M connectors



PCI
Isolated RS-232/422/485

Ports	2
Item #	7203
Price	$329

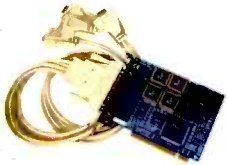
- Each port individually configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- Optical isolation provides protection against transients and ground loops
- 16C850 buffered UARTs with 128-byte FIFOs
- Data rates to 460.8K bps
- Two DB-9M connectors



PCI
RS-232

Ports	4
Item #	7401-DB9
Price	$229

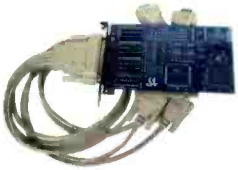
- 16C554 buffered UART with 16-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- 36" cable terminates to four DB-9M connectors
- Available with DB-25M fan-out cable



PCI
RS-422/485

Ports	4
Item #	7402
Price	$279

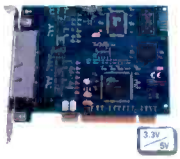
- Each port individually configurable for RS-422 or RS-485
- RS-485 auto-enable circuit
- 16C550 buffered UARTs with 16-byte FIFOs
- Data rates to 460.8K bps
- 36" cable terminates to four DB-9M connectors



PCI
RS-232/422/485

Ports	4
Item #	7404
Price	$319

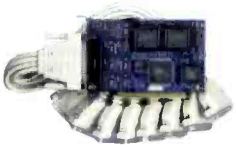
- Each port individually configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- 16C864 buffered UART with 128-byte FIFOs
- Data rates to 460.8K bps
- 36" cable terminates to four DB-9M connectors



PCI
RS-232/485

Ports	4
Item #	7405
Price	$319

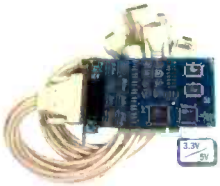
- Each port individually configurable for RS-232 or RS-485
- RS-485 auto-enable circuit
- 16C864 buffered UART with 128-byte FIFOs
- Data rates to 921.6K bps
- Four RJ45 connectors
- Power (+5V or +12V) provided on pin 5 of each connector



PCI
RS-232

Ports	8
Item #	7801
Price	$299

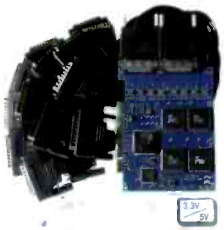
- 16C554 buffered UARTs with 16-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- 36" cable terminates to eight DB-25M connectors
- Available with DB-9M fan-out cable



PCI
RS-232/422/485

Ports	8
Item #	7804
Price	$449

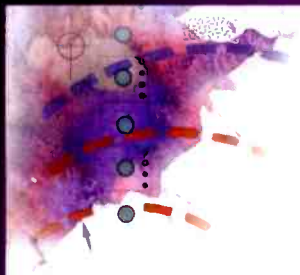
- Each port individually configurable for RS-232, RS-422, or RS-485
- RS-485 auto-enable circuit
- 16C864 buffered UARTs with 128-byte FIFOs
- Data rates to 921.6K bps
- 36" cable terminates to eight DB-9M connectors



PCI
RS-232

Ports	16
Item #	7161
Price	$599

- 16C854 buffered UARTs with 128-byte FIFOs
- Data rates to 460.8K bps
- All modem control signals implemented
- Two 36" cables terminate to 16 DB-25M connectors
- Available with DB-9M fan-out cables



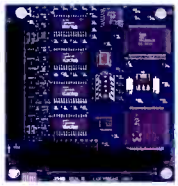
Serial I/O

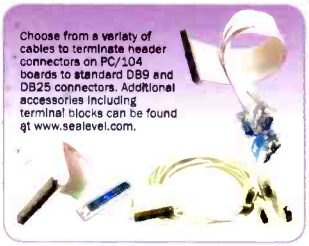
PC/104

Embed with assurance. Sealevel PC/104 modules offer flexible serial expansion options and are designed to meet the core needs of PC/104 applications requiring high reliability, small size, and long-term availability. Sealevel PC/104 modules are available in extended temperature versions (-40°C to +85°C) suitable for the most demanding applications.

PC/104 Modules

For easy configuration even after installation, 3540 modules offer four serial ports individually software-selectable for RS-232, RS-422, or RS-485. For serial intensive applications, the 3588 provides eight two-wire RS-485 ports. The board includes UARTs with 128-byte FIFOs for fast, error-free communications at data rates to 921.6K bps.





PC/104 Serial Adapters					
Item#	Ports	RS-232	RS-422	RS-485	Price
3551	1	•			$99
3550	1		•	•	$109
3502	2	•	•	•	$169
3542	4	•			$179
3543	4		•	•	$189
3544	4	•	•	•	$199
3540	4	•	•	•	$279
3588	8			•	$219

PC/104 I/O Kits

Sealevel PC/104 kits offer a standardized method for interfacing real-world I/O connections. Simply design our 3.2" x 3.1" "Portholes" into your enclosure to mix and match PC/104 I/O kits for maximum configurability. See our PC/104 kits in action in our Relio embedded I/O servers (pp. 20-21). Find details on our full line of PC/104 products and accessories at www.sealevel.com.

4 Port RS-232/422/485

Item# 3541-KT

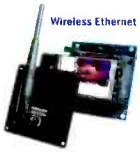
16 Opto-Isolated Inputs/ 16 Reed Relay Outputs

Item# 3730-KT

8 Channel A/D, 2 Channel D/A

Item# 3820-KT

Wireless Ethernet



Item# 3950-KT

Serial I/O

PCMCIA & CompactFlash®

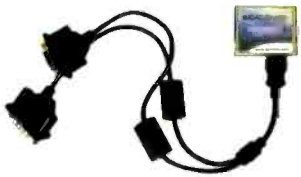
Get mobile. Sealevel PCMCIA and CompactFlash cards add RS-232, RS-422, and RS-485 functionality to laptops, PDAs, tablets, and other portable devices not normally equipped with serial ports. Robust software drivers make installation a snap. All products conform strictly to industry specifications guaranteeing compatibility with your host device.

PCMCIA Cards

Easily add one or two serial ports via PCMCIA expansion slots. The flexible 3623 PCMCIA serial interface card provides two serial ports individually configurable for RS-232, RS-422, or RS-485. The card implements all modem control signals for maximum compatibility with a wide range of peripherals. The 3604 uses a high-speed UART with 128-byte FIFOs and supports RS-232 data rates to 460.8K bps.

PCMCIA Serial Cards

Item#	Ports	RS-232	RS-422	RS-485	Connector	Price
3603	1	•			DB-25M	$199
3604	1	•			DB-25M	$249
3602	1		•	•	DB-25M	$199
3622	2	•			DB-9M	$299
3623	2	•	•	•	DB-25M	$339



CompactFlash Adapters

Sealevel CompactFlash modules are compatible with both 3.3V and 5V host devices and can operate at speeds up to 921.6K bps. Designed for harsh environments, the 3201 dual-port RS-232 card provides optical isolation to protect the host device from potentially damaging voltage transients and ground loops. All Sealevel CompactFlash serial cards are supported by Windows® CE, CE .NET, and Windows Mobile® equipped Pocket PCs, PDAs, and handheld PCs. Simply insert the card in an available CompactFlash slot and it will be recognized by the host device.

CompactFlash Serial Adapters

Item#	Ports	RS-232	RS-422	RS-485	Isolated	Connector	Price
3101	1	•				DB-9M	$119
3102	1		•	•		DB-9M	$149
3201	2	•			•	DB-9M	$189

Serial I/O

Synchronous

When timing matters. Critical military, aerospace, and commercial applications depend on Sealevel designs for the most reliable synchronous communications available. Choose from a variety of RS-232 and RS-232/422/485 multi-interface products that support HDLC/SDLC protocol using our SeaMAC V4 device driver. SeaMAC V4 also supports certain configurations of monosync, bisync, and raw modes. Optional cables are available to connect RS-449, RS-530, RS-530A, V.35, and X.21 interfaces. Contact our knowledgeable technical support staff or visit our website for more details.

PCMCIA & Low Profile PCI

Perfect for a variety of portable synchronous serial applications, the 3612 PCMCIA serial interface utilizes a Zilog® Z85233 Enhanced Serial Communication Controller (ESCC) and terminates to a DB-25M connector. For high-speed applications, the 5104 low profile PCI serial interface provides one synchronous serial port capable of data rates to 10M bps. The board utilizes a Zilog Z16C32 Integrated Universal Serial Controller (IUSC) with built-in DMA controller, 256 bytes static memory, and 32-byte FIFOs. The 5104 offers universal bus (3.3V and 5V) compatibility with both new and legacy computers.

Ribbon and molded interface cables are available for RS-232/422/485/449/530, V.35, and X.21. Additional accessories are available at www.sealevel.com.

Serial I/O - Synchronous

Item#	Bus	RS-232	RS-422	RS-485	Controller	Max. Data	Price
5103	Low Profile PCI	•			Z85230	128K bps	$299
5104	Low Profile PCI	•	•	•	Z16C32	10M bps	$499
5102	PCI	•	•	•	Z85230	128K bps	$309
3512	PC/104	•	•	•	Z85230	128K bps	$259
3514	PC/104-*Plus*	•	•	•	Z16C32	10M bps	$499
3612	PCMCIA	•	•	•	Z85233	64K bps	$339

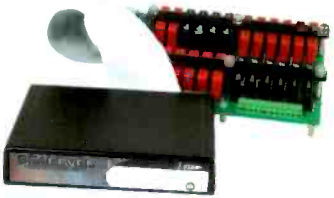
PC/104-*Plus*

The 3514 PC/104-*Plus* serial interface provides one synchronous serial port configurable for RS-232, RS-422, or RS-485. The 3514 utilizes a Zilog Z16C32 IUSC with built-in DMA controller, 256 bytes static memory, and 32-byte FIFOs. The module is capable of data rates to 10M bps and can operate with either 3.3V or 5V signal levels for maximum compatibility with a variety of host processors.

Digital I/O

USB

Control more with USB. Sealevel USB digital I/O products are an effective way to monitor and control a variety of signals from sensors, switches, push buttons, and industrial automation systems. Choose from optically isolated inputs, Reed and Form C relay outputs, and TTL interfaces. DIN-rail mounting is supported, and extended temperature versions are available. To simplify installation, a printed copy of the *USB Digital I/O QuickStart Guide* is included with all USB digital I/O orders.



TTL Interface
Monitor and control high-voltage AC and DC loads from any computer's USB port with Sealevel 8203 and 8205 modules. Both products use standard 50-pin ribbon cable connections compatible with industry-standard relay racks. Find details on our line of solid-state relays and relay racks at www.sealevel.com.

USB Digital I/O

Item#	Inputs	Outputs	USB Powered	Price
8209	8 Optically Isolated	8 Reed Relays	•	$259
8206	8 Optically Isolated	8 Form C Relays	•	$269
8207	16 Optically Isolated		•	$229
8208		16 Reed Relays	•	$299
8203	48 Channel Parallel I/O (TTL)			$229
8205	96 Channel Parallel I/O (TTL)			$279

The Digital I/O Handbook, available at www.sealevel.com, clearly explains real-world digital input/output implementation from both a hardware and software perspective.

Isolated Inputs/Relay Outputs
The versatile 8206 adapter provides 8 optically isolated inputs and 8 Form C relay outputs well-suited to many PC-based control and automation applications. The Form C relays are rated up to 60VDC @ 2A, while the inputs are compatible with 24VDC signals. The 8206 is powered from the USB connection and onboard removable screw terminals simplify field wiring.

ECN Technology Awards

Digital I/O

Seal/O Data Acquisition Modules

Distribute control. Seal/O modules connect to a host PC or controller via Ethernet, USB, RS-485, or RS-232, and multiple units can be daisy chained using convenient pass-through connectors to create a powerful distributed control and monitoring network.

Choose from a variety of I/O configurations, each designed for maximum flexibility and easy field wiring. For quick software implementation, application programs or third-party software can use Sealevel's SeaMAX libraries or industry-standard Modbus protocol.

- Powerful software configuration & diagnostic tools
- Address selectable via software or switch
- Easily daisy chain multiple units
- Selectable RS-485 line conditioning
- Flexible mounting options
- Modbus TCP and Modbus RTU compatible

Intelligent Control — Choose One

BASE MODULES	HOST INTERFACE	BENEFITS	PRICE
E-Series	Ethernet Modbus TCP	E-Series modules are compatible with 10/100BaseT Ethernet and allow remote monitoring and control of digital and analog I/O from anywhere on your network. Compatibility with Modbus TCP allows communication with Modbus-compliant devices over any TCP/IP network.	From $419
M-Series	RS-485 Modbus RTU	M-Series and S-Series modules offer a convenient method for adding digital I/O to industrial computers and legacy PLC systems. The modules communicate with a host using industry-standard Modbus RTU protocol and are compatible with third-party Modbus software.	From $289
S-Series	RS-232 Modbus RTU		From $309
U-Series	USB Modbus RTU	U-Series modules provide digital and analog I/O through any available USB port. Sealevel is the first to allow a distributed I/O network to be controlled from a traditional point-to-point USB host connection transforming any USB-equipped PC into a powerful controller.	From $299

Expandable I/O — Add Many

EXPANSION MODULES	SEAL/O INTERFACE	BENEFITS	PRICE
N-Series	Connects to Base Modules via RS-485 Modbus RTU	N-Series expansion modules communicate with Base modules via RS-485 Modbus RTU and allows mixing and matching up to 246 expansion units to create the most efficient I/O configuration. Expansion modules can be located together with the Base module, or a network of expansion modules can be distributed throughout your facility using RJ45 pass-through connectors included on each Seal/O device and inexpensive CAT5 cabling.	From $239

SeaI/O – 16 Isolated Inputs/ 16 Reed Relay Outputs

Item # 410 Series
Price From $309

- 16 nonpolarized optically isolated inputs
- 30VDC max. input
- 300V isolation
- 6.2K ohms series input resistance
- 16 SPST Form A Reed relays
- 60VDC @ 500mA max. contact rating

SeaI/O – 16 Isolated Inputs/ 8 Form C Outputs

Item # 420 Series
Price From $279

- 16 nonpolarized optically isolated inputs
- 30VDC max. input
- 300V isolation
- 6.2K ohms series input resistance
- 8 SPDT Form C relays
- 60VDC @ 2A max. contact rating

SeaI/O – 32 Isolated Inputs

Item # 430 Series
Price From $269

- 32 nonpolarized optically isolated inputs
- 30VDC max. input
- 300V isolation
- 6.2K ohms series input resistance

SeaI/O – 32 Reed Relay Outputs

Item # 440 Series
Price From $359

- 32 SPST Form A Reed relays
- 10VA max. power
- 60VDC max. contact voltage
- 500mA max. contact current

SeaI/O – 16 Form C Relay Outputs

Item # 450 Series
Price From $289

- 16 SPDT Form C relays
- 60VDC max. contact voltage
- 2A max. contact current
- Normally-open and normally-closed contacts on connector

SeaI/O – 96 Bit TTL I/O

Item # 462 & 463 Series
Price From $239

- 96 bits of buffered TTL I/O
- Programmable as input or output in 8-bit groups
- 462 Series - Two DB-78 connectors
- 463 Series - Standard 50-pin ribbon cables

SeaI/O – Analog & Digital I/O Combo

Item # 470 Series
Price From $489

- 8 differential or 16 single-ended 12-bit A/D inputs
- Inputs configurable for 4-20mA inputs
- 2 12-bit D/A outputs
- 8 optically isolated inputs
- 8 open-collector 24V outputs

SeaI/O – 8 Isolated Inputs/ 8 High-Current Form C Outputs

Item # 520 Series
Price From $299

- 8 nonpolarized optically isolated inputs
- 30VDC max. input
- 8 high-current Form C relays
- 240VAC/125VDC max. contact rating
- 7A max. contact current

Digital I/O

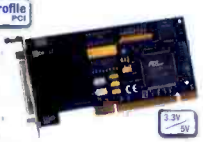
PCI

Place your PC in control. Sealevel PCI digital I/O boards offer a variety of input and output configurations to best match your application requirements. Optically isolated inputs protect the host computer from transients and ground loops commonly found in industrial environments, while Reed and Form C relay outputs provide reliable, long-life switch closures. Reed relays are normally open and close when energized. Form C relays include both normally open and normally closed contacts and can handle higher current loads. For high-voltage requirements, our TTL interfaces provide convenient connections to industry-standard solid-state relay racks.

Choose from a number of helpful accessories to simplify digital I/O applications. Terminal blocks that break out molded cables to screw terminals are especially helpful for connecting field wiring.

Terminal blocks, relay racks, solid-state relays, and additional digital I/O accessories are available at www.sealevel.com.

Low Profile PCI



Low Profile PCI
8 Isolated Inputs/
8 Reed Relay Outputs

I/O	8/8
Item #	8012
Price	$239

- Eight optically isolated inputs
- 30VDC max. input
- Eight SPST Form A Reed relays
- 60VDC @ 500mA max. contact rating
- Power (+5V and +12V) and ground provided on connector
- DB-44F connector

Low Profile PCI

Low Profile PCI
24 Channel TTL

I/O	24
Item #	8018
Price	$159

- 24 channels of buffered TTL I/O
- Each 8-bit port individually configurable as input or output
- Each bit will sink 24mA or source 15mA
- 10K pull up resistors on each bit
- +5V power and ground provided on connector
- 40" cable terminates to industry-standard 50-pin IDC connector

PCI
32/48/96 Channel TTL

I/O	Item #	Price
32	8010	$179
48	8005	$199
96	8009	$299

- 32, 48, or 96 channels of buffered TTL I/O
- Each 8-bit port individually configurable as input or output
- Each bit will sink 24mA or source 15mA
- 10K pull up resistors on each bit
- +5V power and ground provided on connector
- Industry-standard 50-pin header connectors

3.3V 5V denotes universal bus PCI compatible with 3.3V & 5V systems

PCI
16 Isolated Inputs

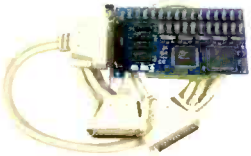
I/O	16
Item #	8006
Price	$219

- 16 optically isolated inputs
- 30VDC max. input
- 300V isolation
- Power (+5V and +12V) and ground provided on connector
- DB-37F connector

PCI
16 Reed Relay Outputs

I/O	16
Item #	8003
Price	$259

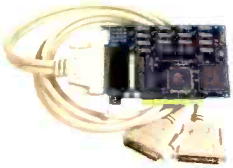
- 16 SPST Form A Reed relays
- 60VDC @ 500mA max. contact rating
- Power (+5V and +12V) and ground provided on connector
- DB-37M connector



PCI
32 Reed Relay Outputs

I/O	32
Item #	8007
Price	$469

- 32 SPST Form A Reed relays
- 60VDC @ 500mA max. contact rating
- Power (+5V and +12V) and ground provided on connector
- 72" cable terminates to two DB-37M connectors



PCI
16 Isolated Inputs/
16 Reed Relay Outputs

I/O	16/16
Item #	8004
Price	$399

- 16 optically isolated inputs
- 30VDC max. input
- 300V isolation
- 16 SPST Form A Reed relays
- 60VDC @ 500mA max. contact rating
- 72" cable terminates to DB-37M and DB-37F connectors

PCI
8 Isolated Inputs/
8 Form C Relay Outputs

I/O	8/8
Item #	8011
Price	$249

- Eight optically isolated inputs
- 30VDC max. input
- 300V isolation
- Eight SPDT Form C relays
- 60VDC @ 2A max. contact rating
- DB-44F connector

Digital I/O

PC/104 & el/O

Optimize I/O solutions. Sealevel PC/104 and el/O modules interface to a wide variety of inputs and outputs and are perfect for military or commercial applications where small size and ruggedness are paramount.

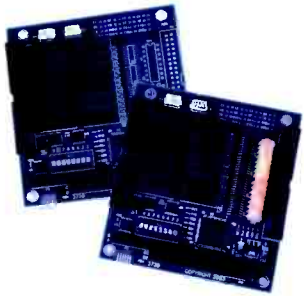
For maximum flexibility, el/O modules offer expansion in groups of eight inputs or eight outputs per module. This modularity allows the user to mix and match modules providing relay, optically isolated in/out, and other commonly used I/O to create a customized embedded I/O subsystem optimized for size and cost-effectiveness. Connection to el/O modules is accomplished via an industry-standard 50-pin cable interface (PB24/32) compatible with a number of bus-based controllers including Sealevel's PIO series of boards and USB adapters.

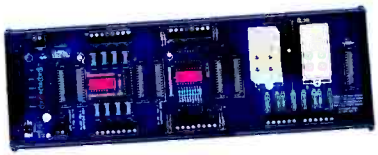
Quad Solid-State Relay(QSSR) modules are available at www.sealevel.com to connect high-voltage AC and DC signals.

PC/104 Digital I/O

Item#	Inputs	Outputs	Price
3710		16 Reed Relays	$249
3720	16 Optically Isolated		$219
3730	16 Optically Isolated	16 Reed Relays	$279
3701	48 Channel Parallel I/O (TTL)		$149

Note: PC/104 analog I/O modules also available





el/O Modules

Item#	Baseboards		Price
M200	Baseboard Module Interfaces to el/O Input/Output Boards		$69
M210	Expansion Module Connects PC/104 3810/3820 Boards to el/O Input/Output Boards and 5B Signal Conditioning Modules		$89
Item#	**Inputs**	**Outputs**	**Price**
M240	8 Optically Isolated		$79
M250		8 Opto-Isolated Darlington Array, Open-Collector	$79
M251		8 Opto-Isolated Source Driver, Emitter-Follower	$79
M260		8 Form A Relays	$89
M270		8 Form C Relays (2A)	$99
M271		8 Form C Relays (8A)	$109
M280	Carrier Board Accepts 1 or 2 QSSR Input/Output Modules		$69

Industrial Computing

Relio Embedded I/O Servers

Expand with reliability. Designed for I/O intensive applications where ruggedness is a must, the Relio family of embedded I/O servers combines the reliability of a PLC with the configurability of an industrial computer. Relio systems are completely fanless. Embedded software can run from CompactFlash, eliminating hard drives and resulting in true solid-state operation. The Relio's unmatched expansion capabilities can be readily adapted to a wide variety of OEM and industrial applications. All Relio systems offer:

- Bullet-Proof Reliability
- Solid-State Operation
- Versatile I/O Selection
- Wide Temperature Range
- Shock and Vibration Tolerance
- Dependable Design Consistency
- Long-Term Availability

Choose from three versions of Relio systems, each providing powerful standard features and expansion options.

Relio™ R1000

R1000 systems provide all core processing functions in a rugged metal enclosure small enough to mount in virtually any application. Based on a 600MHz ULV Intel® Celeron® M processor, the system offers excellent computing power, low power consumption, and wide operating temperature range. Standard I/O includes 10/100BaseT Ethernet, dual serial ports, USB, and analog video. Local or remote I/O expansion is available using Sealevel Seal/O modules.

Available in a variety of configurations providing optically isolated inputs, relay outputs, and TTL interfaces to industry standard solid-state relay racks, up to 247 Seal/O modules can be controlled by the R1000 via RS-485 Modbus RTU. Using the convenient VESA mounting adapter, the R1000 and Seal/O expansion modules mount directly to LCD monitors to create a robust, expandable flat panel computing solution. Call today or visit our website for more information.

Features

600MHz ULV Intel Celeron M processor
CompactFlash socket
Up to 1GB RAM
10/100BaseT Ethernet
Two serial ports
High-speed USB 2.0 port
Dual USB 1.1 ports
Analog video
9-30VDC power input
Compact size - 7.5"(L) x 5.1"(W) x 1.8"(H)
Wide temperature operation - 0°C to 50°C

R1000 with Seal/O Expansion

R1000 with Seal/O Expansion and Flat Panel Monitor

Relio R2000

Available with up to a 1.4GHz Intel Pentium® M processor, the R2000 offers exceptional performance and flexible I/O expansion. Fanless operation is possible up to 50°C, and using the Windows XP Embedded operating system you can operate from CompactFlash, achieving the ultimate in reliability — no moving parts.

Packed with standard features including dual 10/100BaseT Ethernet, two serial ports, and two USB ports, the R2000 excels in I/O intensive applications. Expand with up to three PC/104 kits (p. 10) that terminate to real-world connectors on the rear of the R2000 chassis. A Seal/O module (p. 14) or a CDRW/DVD can be installed in the front of the chassis.

Features

Processors
- 400MHz ULV Intel Celeron
- 650MHz ULV Intel Celeron
- 933MHz LV Intel Pentium III
- 600MHz ULV Intel Celeron M
- 1.0GHz ULV Intel Celeron M 373
- 1.4GHz Intel Pentium M 738

CompactFlash socket
Optional hard disk drive
Up to 1GB RAM
Dual 10/100BaseT Ethernet
Two serial ports
Dual USB 1.1 ports
Analog video
5VDC power input; optional redundant 18-30VDC input
11.4"(W) X 8.0"(D) X 4.4"(H)
Wide temperature operation - 0°C to 50°C

R2000 with Three PC/104 Expansion Modules Installed

DC Power Input

R2000 systems can be powered from a 5VDC source or choose the redundant 18-30VDC option for ultimate reliability.

R2000 with Sealevel Seal/O & PC/104 Expansion Installed

R2000 with Optional CD-ROM Installed

Relio R3000

Designed for installation in 19" EIA racks, Relio R3000 systems offer a wealth of standard I/O including dual 10/100BaseT Ethernet, four RS-232/422/485 serial ports, four USB ports, and analog video. For I/O intensive applications, interface to a wide variety of real-world devices using Sealevel's robust PC/104 kits (p. 10) or Seal/O modules (p. 14).

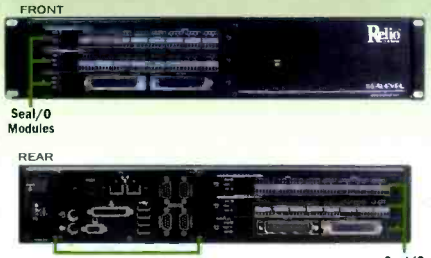
R3000 systems offer unmatched expansion capabilities. Unique I/O plates allow access to PC/104 or Seal/O connections on both the front and rear of the enclosure. Maximum configurations allow three Seal/O modules with three PC/104 kits, or six Seal/O modules. An optional CD-ROM can replace one Seal/O module.

Features

Processors
- 400MHz ULV Intel Celeron
- 650MHz ULV Intel Celeron
- 933MHz LV Intel Pentium III
- 600MHz ULV Intel Celeron M
- 1.0GHz ULV Intel Celeron M 373
- 1.4GHz Intel Pentium M 738

CompactFlash socket
Optional hard disk drive
Up to 1GB RAM
Dual 10/100BaseT Ethernet
Four RS-232/422/485 serial ports
Four USB 1.1 ports
Analog video
5VDC power input; optional redundant 18-30VDC input
17.0"(W) X 11.0"(D) X 3.5"(H)
Wide temperature operation - 0°C to 50°C

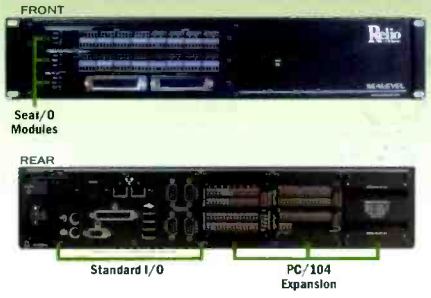
R3000 with Six Seal/O Modules Installed



DC Power Input

R3000 systems can be powered from a 5VDC source or choose the redundant 18-30VDC option for ultimate reliability.

R3000 with Three Seal/O & Three PC/104 Modules Installed



Seal/O & PC/104 Modules can be installed in front and rear.

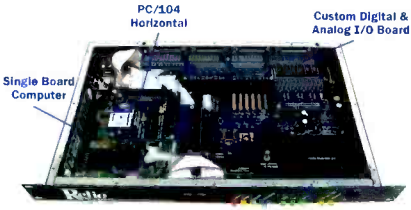
R3000 with Optional CD-ROM & Two Seal/O Modules Installed

Relio Custom Designs

Sealevel's design team can create a custom Relio system optimized for your particular application. You can even begin development immediately on a standard Relio while your custom unit is designed. Full details are available in our Relio brochure or by visiting our website.

Take a look at what we've done for other customers:

Relio™ CUSTOM

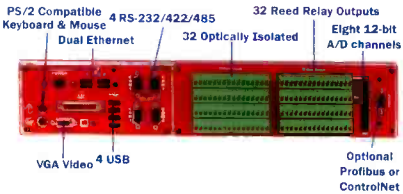


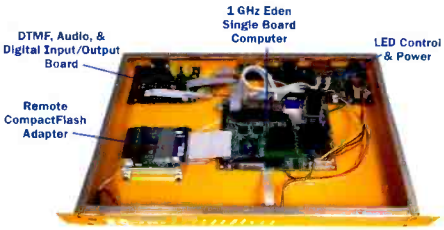
Emergency Communications

Designed for deployment in remote locations, this 1U rackmount Relio system operates on the Windows XP Embedded operating system and incorporates 120 optically isolated inputs, 96 digital outputs, 40 12-bit A/D channels, serial, USB, and Ethernet functionality. Color LEDs on the front panel display system health and other parameters.

Public Security Systems

Used as a controller in a Homeland Security application, this 2U Relio includes 32 optically isolated inputs, 32 relay outputs, A/D, D/A, and fieldbus connectivity. Removable screw terminals make digital and analog I/O wiring convenient. 64 discrete LEDs mounted in the front of the enclosure display real-time I/O status for easy troubleshooting.





Event Notification

A customer specializing in hazardous event warning systems contracted Sealevel to design a 1U rackmount Relio that included DTMF (Dual-Tone Multi-Frequency) and event monitoring capabilities. The system runs from CompactFlash on the XPe platform and uses eight tricolor LEDs to display status information.

Software

Sealevel Software Suite

Sealevel software enables maximum utilization of our entire family of I/O products. Driver level and application support across multiple operating systems including Windows, Linux®, and QNX® facilitate rapid prototyping and debugging. Whether your application requires robust serial communications or digital control/monitoring, Sealevel software provides the solution.

The Sealevel Software Suite consists of:

SeaCOM
Asynchronous Serial Drivers for Windows 95/98/ME/NT/2000/XP
SeaCOM advanced serial drivers make using our asynchronous serial products easy. SeaCOM provides IRQ sharing, support for a variety of UARTs (16C650, 16C750, 16C850, 16C950), 9-bit data support, isochronous communication, and automatic RS-485 RTS enable for products without automatic hardware control. Included applications allow terminal mode operations, bit error rate testing (BERT), and throughput monitoring. Recent versions of Linux and QNX offer native support for Sealevel asynchronous devices; call for details.

SeaMAC
Synchronous Serial Drivers for Windows 2000/XP and Linux
SeaMAC (Sealevel Systems Media Access Control) offers a family of developer oriented solutions for Windows and Linux. SeaMAC supports many popular protocols including HDLC/SDLC and certain configurations of bisync, monosync, and raw (bit-shifter) modes. Check our website for more detailed information on supported protocols and software partners. With SeaMAC, implementing fast, error-free synchronous communication is easier than ever.

SeaMAX
Seal/O Module Software for Windows 2000/XP
SeaMAX software is a collection of software libraries, configuration utilities, and diagnostic tools that facilitate rapid application development for Modbus-compliant Seal/O modules. Linux support is also offered; call for details.

SeaLINK
Ethernet Serial Drivers for Windows 98/ME/NT/2000/XP
SeaLINK is the virtual COM port redirector used with Sealevel Ethernet serial servers that enables any host to transparently access serial devices across a TCP/IP network. Applications can communicate with the virtual COM ports on a remote Ethernet serial server as easily as if they were directly connected to the host computer.

Seal/O
Digital I/O Drivers for Windows 98/ME/NT/2000/XP and Linux
Seal/O is a developer's toolkit for Sealevel PCI, USB, PC/104, and ISA digital I/O products. Seal/O allows control of individual relays or groups of relays. Direct input and programmable timed monitoring of inputs with event notification is also supported.

Sample & Utility Software
All Sealevel software includes a variety of samples and utilities to reduce development time and assist in troubleshooting. Source code is included for all samples and is often useful in end-user application programs.

Accessories

Sealevel accessories allow one-stop shopping for all your serial and digital I/O requirements.

- Cables
- Terminal Blocks
- Books & References
- Adapters & Converters
- Power Supplies
- Wireless Devices
- Relay Racks & Relays
- USB Devices
- Ethernet Devices
- Racks & Brackets
- Seal/O Accessories
- Industrial Computing Accessories

Please visit our website at www.sealevel.com for a complete listing.

We Listen. Think. And Create.

SEALEVEL

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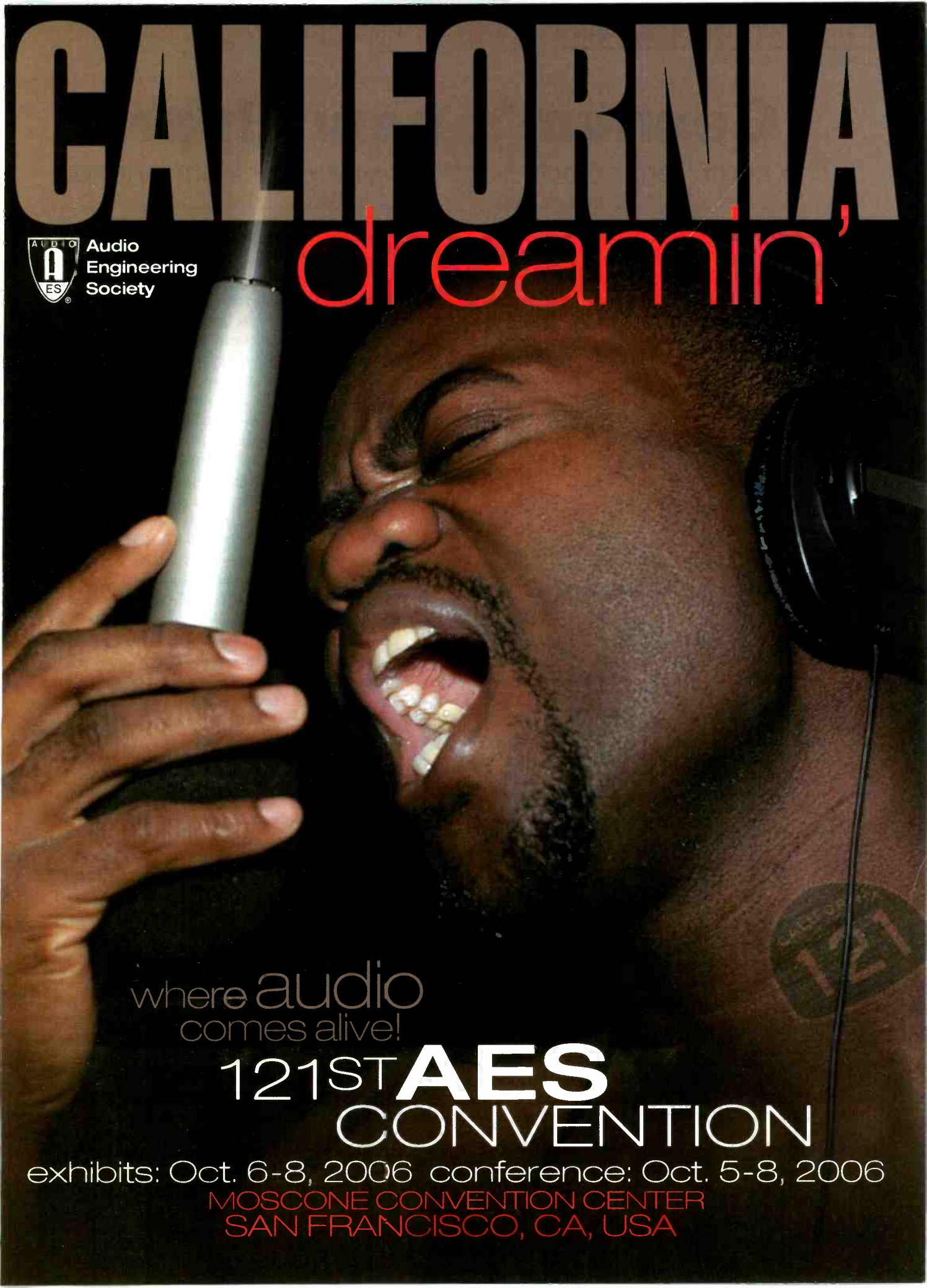
CALIFORNIA
dreamin'
Audio
Engineering
Society
where audio
comes alive!
121ST AES
CONVENTION
exhibits: Oct. 6-8, 2006 conference: Oct. 5-8, 2006
MOSCONE CONVENTION CENTER
SAN FRANCISCO, CA, USA

Gennum's new chips

The equalizer, reclocker and driver are for 3Gb/s video.

BY JOHN HUDSON AND NIGEL SETH-SMITH

When TV networks were first established, video signals were distributed on 75Ω coaxial cables and terminated with BNC connectors. When the video signal transitioned to SDI (SMPTE 259M) and again to HD-SDI (SMPTE 292M), the 75Ω coax infrastructure was retained. It's many advantages include support for high frequencies, physical robustness and simple connectivity.

The need for even higher speed interfaces keeps growing. Can this be achieved while retaining the existing cable infrastructure?

A higher capacity interface

In North America, the dominant broadcast HDTV standards are 720p60 and 1080i60. The EBU supports both 720p50 and 1080i50. It is probable that many production facilities will want to distribute in both formats, perhaps broadcasting in 720p but producing a DVD in 1080i. (See Figure 1.)

This places production facilities in a quandary when trying to decide on a production format. One option is to produce content in a 1080-line progressive format, which can be converted to either emission transport with minimal quality degradation.

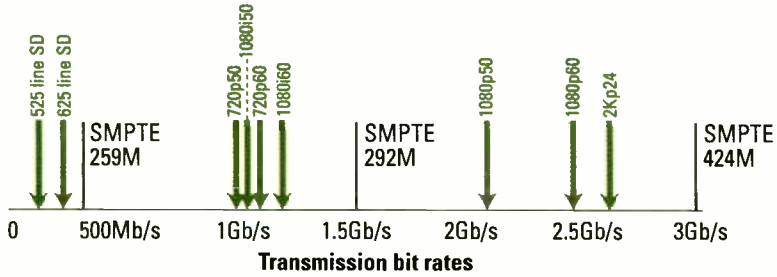

Figure 1. Required bit rate to transmit various image formats

Another application that exceeds SMPTE 292M bandwidth requirements is digital cinema. Its interfaces typically use multiple 1.5Gb/s links, which are expensive and awkward to implement. The use of mezzanine compression would allow higher bandwidth signals to be squeezed into a single 1.5Gb/s link. This mandates codecs at every input and output. The compression scheme would also need to be carefully designed to minimize image degradation and latency.

A more cost-effective way to support these rate formats is to extend the capability of SDI to 2.97Gb/s. New SMPTE and ITU standards have been introduced for such an interface. However, to be cost-effective, the equipment must reuse the installed base of HD-SDI cabling, patch panels and BNC connectors. Gennum now offers semiconductor devices for a 2.97Gb/s SDI interface capable of operating over existing HD-SDI cabling and plant.

Cable characteristics

One major limiting factor for sending high-speed data over copper cables is the skin effect (increased attenuation as the signal frequency increases). Other factors, such as impedance mismatches at connectors, also limit cable length performance at high bit rates, but beyond 20m, losses are dominated by the skin effect. This effect is due to AC currents flowing mostly on a conductor's surface (skin) at high frequencies. DC and low-frequency currents, present throughout a conductor's cross-section, see resistance inversely proportional to the square of the conductor's diameter. The skin effect forces higher frequency currents to traverse a smaller cross-section, resulting in significantly greater attenuation. This makes designing low-loss cables for high-frequency signals difficult, even when the application can tolerate

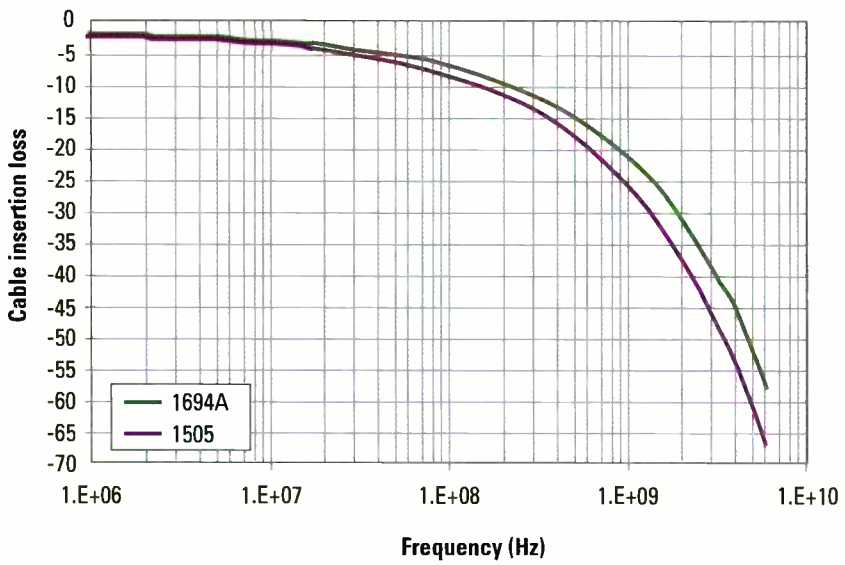

Figure 2. Insertion loss of a 100m section of two types of coaxial cable used in broadcast

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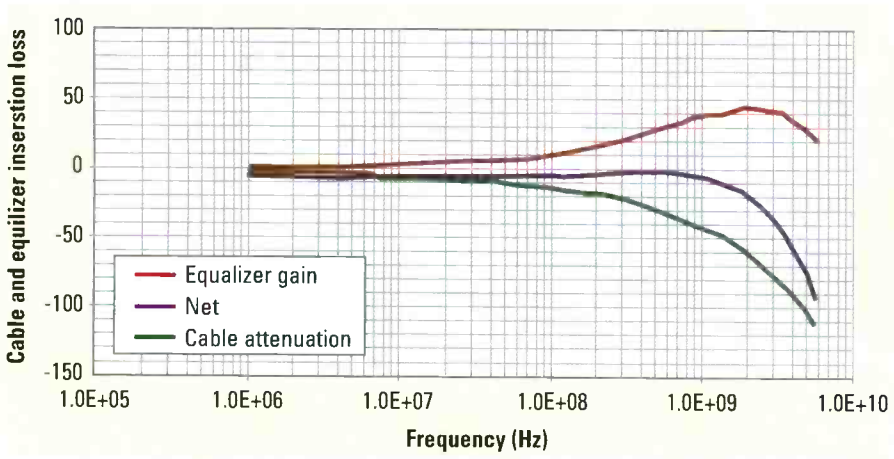

Figure 3. Cable insertion loss and equalizer gain

physically large cables. The result is that the insertion loss of a piece of cable increases as the square root of the frequency of the signal it carries. (See Figure 2 on page 92.)

3Gb/s cable equalization

A cable equalizer is needed to properly receive the signal. It is a filter with a frequency response that is the complement of the cable response. The Gennum GS2974 is an adaptive cable equalizer for SMPTE SDI signal rates from 143Mb/s to 2.970Gb/s. It compensates for cable loss at frequencies greater than 1.5GHz, making it suitable for use with 3Gb/s data. (See Figures 3 and 4.)

3Gb/s data reclocking

To reduce jitter, a data reclocking circuit is required. Because of the unique data rates and signal characteristics of SDI signals, specific SDI video reclocker devices are required. Datacom or telecom CDR devices generally do not work with SDI signals. Gennum's GS2975 SDI reclocker supports 2.97Gb/s and is compatible with all SMPTE SDI signal rates from 143Mb/s to 2.97Gb/s. (See Figure 5.)

3Gb/s cable driver

In addition to receiving a 3Gb/s signal over long cable runs and recovering an error-free signal, there is a need to drive the cable from a suitable transmitting device. To complete the family of 3Gb/s SDI physical interface components, Gennum also offers a 3Gb/s cable driver, the GS2978. BE

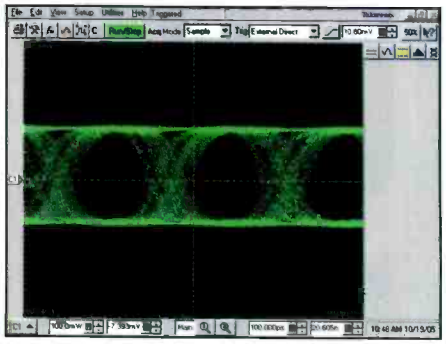

Figure 4. Output of GS2974 after 100m of Belden 1694A cable at 3Gb/s

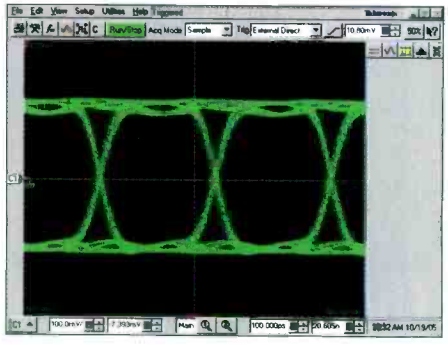

Figure 5. Output of GS2975 after equalizing 100m of cable at 3Gb/s

John Hudson is the manager of new product definition and Nigel Seth-Smith is senior product definition specialist for the video products division at Gennum.

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NETWORKING AUDIO SYSTEMS

Polatis' Trinity

All-optical routers provide support for the future.

BY AARON BENT AND JOHN LIRON

Increasing signal rates and the need to transmit media over greater distances are driving the requirement for an optical fiber infrastructure in today's broadcast network. Contribution-quality HD (1080i/720p) content cannot easily be carried more than 100m on copper without regeneration. The adoption of 1080p (50fps/60fps) is likely to be even more challenging, depending on cable type. Solving this problem with a copper connection requires the use of repeaters, a costly alternative, which results in accumulated jitter. A better option is fiber, and many broadcasters have already incorporated fiber into their facilities

Polatis' Trinity optical video routing switch is an end-to-end optical solution to switching fiber; the signal is maintained as optical throughout the network infrastructure. (See Figure 1.)

It is important to distinguish all-optical routing switches, from those devices with optical-to-electrical (O/E) interfaces, which convert the signal at each intermediate point (fiber-ready). The switcher is capable of routing virtually any audio or video signal, whether analog or digital, providing a universal and future-proof extension to today's formats.

Keeping the signal in the optical domain avoids the multiple re-clocking steps that cause signal jitter to accumulate as well as require re-timing with the house reference. When routing high-bandwidth signals over intermediate and long distances, end-to-end optical solutions can be far less expensive than using repeaters on copper or multiple O/E converters.

Optical performance requirements

Effective routing of optical signals places a unique set of optical performance requirements on the device, including parameters such as low optical insertion loss, high return loss and low optical signal crosstalk; in other words, it requires maximizing the transparency of the router to the signal that passes through it. At the heart of the switch is optical path mapping technology, which directs the optical signal from an input set of fiber ports to an output set of fiber ports. The technology uses solid-state materials, piezoelectric ceramics, to direct collimated light across free space to accomplish the switching function. Accuracy of pointing can be controlled to within fractions of a micron, resulting in typical optical power loss through the router of 0.7dB — little more than that of a fiber connector itself.

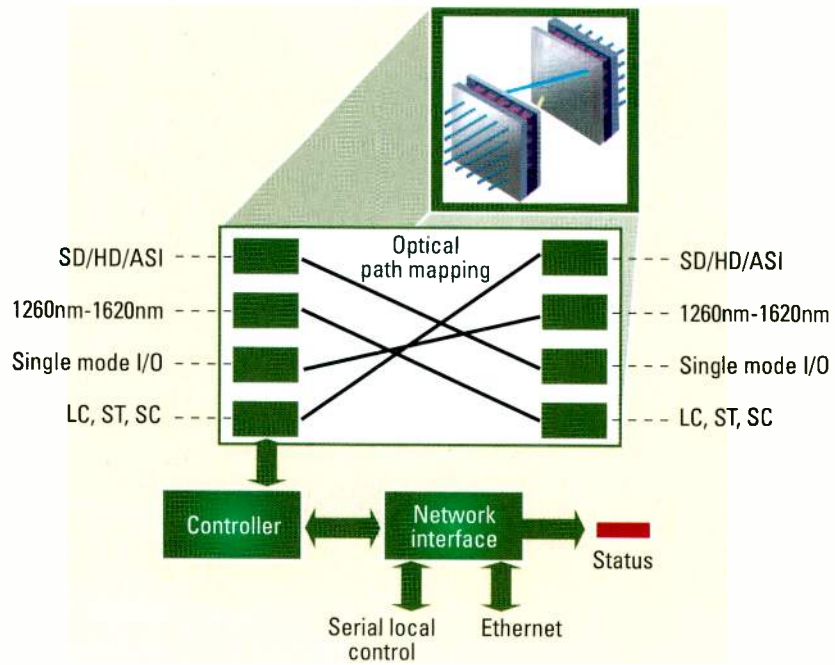

Figure 1. The optical path mapping technology, with inset of the fiber beam-steering concept

At the heart of the switch is optical path mapping technology.

In contrast to other photonic switches, the switch does not require an existing broadcast signal in order to create or maintain a path connection, and it can switch dark fiber. It is also capable of passing bidirectional signals and carrying signals of one or more wavelengths, such as in dense wavelength division multiplexing systems.

To fulfill the role as a mainstream router in HD networks, the switch had to match many of the capabilities of electrical routing switches, while allowing maximum flexibility for new fiber infrastructures. The switch is a nonblocking (Layer 1) switch, with

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An option on the router incorporates smart reconfiguration, which allows the user to swap sources and destinations, creating an asymmetric matrix on demand. For example, a 16 x 16 matrix can become a 4 x 28 or 18 x 14 matrix. This can be particularly useful when interfacing fiber trunks to multiple devices with optical I/O.

Optical interfaces are typically single-mode fiber of LC connector type and are most popular in high-density applications. However, the switch can also be configured to carry multimode fiber signals. The switch currently supports telecom standard protocols, such as TL1, and broadcast control protocols, enabling the routing switch to directly interface to the Thomson Grass Valley SMS-7000, Encore and Jupiter control systems.

The routing switcher has been a key element in broadcast infrastructures for many years. And the control concepts have remained relatively constant even though the signal formats themselves have evolved dramatically.

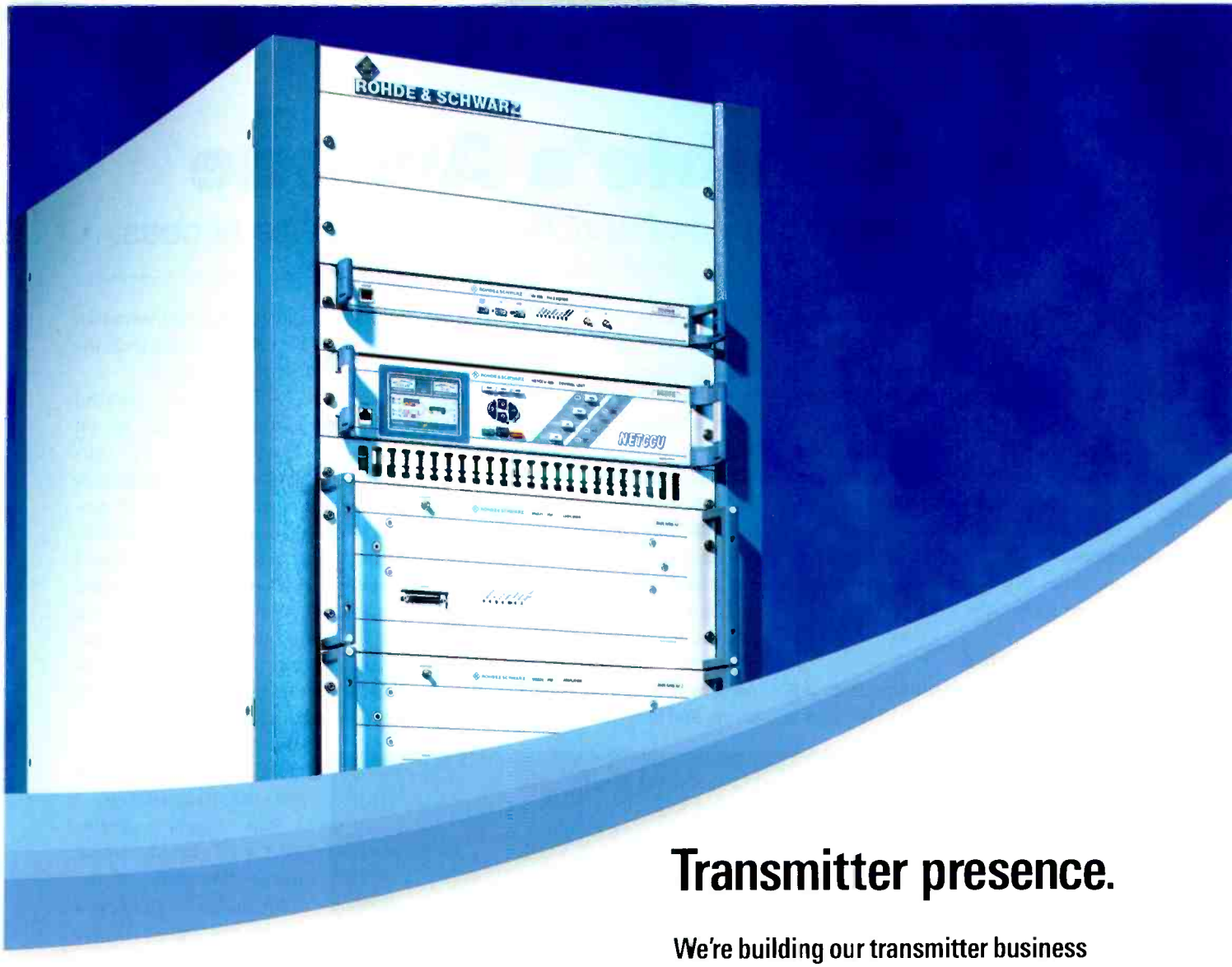
It is, therefore, attractive to integrate the optical layer into the router control system in exactly the same way, with optical path switching controlled from conventional router control panels or from interfaces from the router controller to automation and facility management systems using existing control protocols. The optical layer can be interfaced to the conventional SD/HD layers by using tie lines with embedded O/E conversion or by taking advantage of optical interfaces integrated into broadcast equipment such as the Grass Valley Kameleon and GeckoFlex products. The router control system uses these tie lines to automatically route optical sources to SD/HD destinations or vice versa, as required.

Optical routing will fulfill a key role in the next generation of broadcast networks.

Conclusion

Regardless of where the greatest need first emerges, optical routing switches such as the Trinity switch have the flexibility to handle the breadth of today's formats and the extensibility to manage future formats and line rates. By ensuring such new technologies are also compatible with existing control strategies and traditional routing architectures, new approaches can be more easily adopted. Optical routing will fulfill a key role in the next generation of broadcast networks. BE

Aaron Bent is vice president of marketing and business development for Polatis, and John Liron is the manager of advanced development for Thomson Grass Valley.



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Ensemble's Avenue

The system enhances FastChannel's remote access.

BY ROBIN SHAHID

FastChannel, an IP-centric company that serves broadcasters, was one of the first companies to deliver commercials via IP to stations. Because we have equipment in several locations and are committed to IP technology, all of our video equipment needs to be controllable from remote locations. We have technicians at all of our sites, but we do much of the engineering remotely with IP-based gear.

The situation

We receive spots on tape from advertisers or post houses. The tape is played back and fed into a Grass Valley Concerto router, then through Ensemble Designs' Avenue signal processing gear and into a Telestream ClipMail Pro encoder. ClipMail Pro uploads spots in MPEG-2 to our Boston Network Operations Center's (NOC) proprietary server array. Spots are quality checked from our Chicago location by accessing spots on the NOC server. After QC, the spot is released for distribution and is sent from the NOC server over IP to a TV station. Each station has a FastChannel server on-site. Spots are distributed in MPEG-2, 4:2:2 at 18Mb/s.

With offices in Chicago; Dallas; London; Los Angeles; Memphis, TN; and New York, we need to monitor and control all of the video and audio equipment from any of the locations.

The solution

The sync pulse generator (SPG), distribution amplifiers (DAs) and signal processing gear in Ensemble Designs' Avenue line met our performance criteria for video and audio specifications, remote control over the Internet and customer service responsiveness.

We use the 5400 signal generator, the 5460 and 5465 changeover switches, and the distribution amplifiers. The SPG, switch and DAs all share a 3RU frame that can hold 10 modules. We use one or two frames at each location and populate them with a mix of modules.

The frame and cards arrive in separate boxes from the factory. Cards plug into the frames from the front. All connections, including BNCs, dual power and Ethernet, are on the back of the frame. We like being able to reach the fan from the front, too. Installation was straightforward.

Ensemble Designs' Avenue signal processing equipment allows any combination of HD video, SD video, DVB-ASI and audio modules in the same frame.

The frame has a control card as an option, which should be required with every system. The control card is needed for the Ethernet port to be active, a must for our application. The control card has a slot between the processing cards and the power supplies inside the frame.

It's easiest to set the frame's IP address if the frame has a touch-screen front panel. Otherwise, the IP address is set on the control card edge using a switch and push button, which works fine too. Once this is set, we control the frame through the Avenue PC software or the touch screen. Because we control most equipment remotely, we use the PC software more than the touch-screen control surface.

The PC software can control any frame and its cards that are on the network. We use the PC software to control any of our frames by accessing a particular facility IP network and then targeting the specific frame we want to access. The control system is easy to use. The frames and cards show up in a logical manner on the left side of the screen. We can see all the cards in our system and know what equipment we have on hand; it's all reported to us. We click on a particular card and its controls are displayed, and then we can change any settings.

The signal generator is ID-based, which means the name of the facility can be embedded in the test signal. This is important because when we're accessing signals remotely, we can easily see which facility is originating the feed. We rely on the ability to log in and change to different test signals and adjust levels remotely. The generator also has a tri-level sync output in addition to the standard reference outputs. It's helpful in a dual-standard house. Multiple video, audio and tri-level outputs can be set to different types of signals through the control system.

We use a changeover switch due to the comfort factor. The signal generator is the brain of the operation, so the changeover switch will shift to the other SPG card if necessary. It's not a fancy card, but it's vital. There are three poles on the card that check for signal presence, and we decide which video or audio signals to connect.

The ability to put a distribution amplifier card in with all of the other

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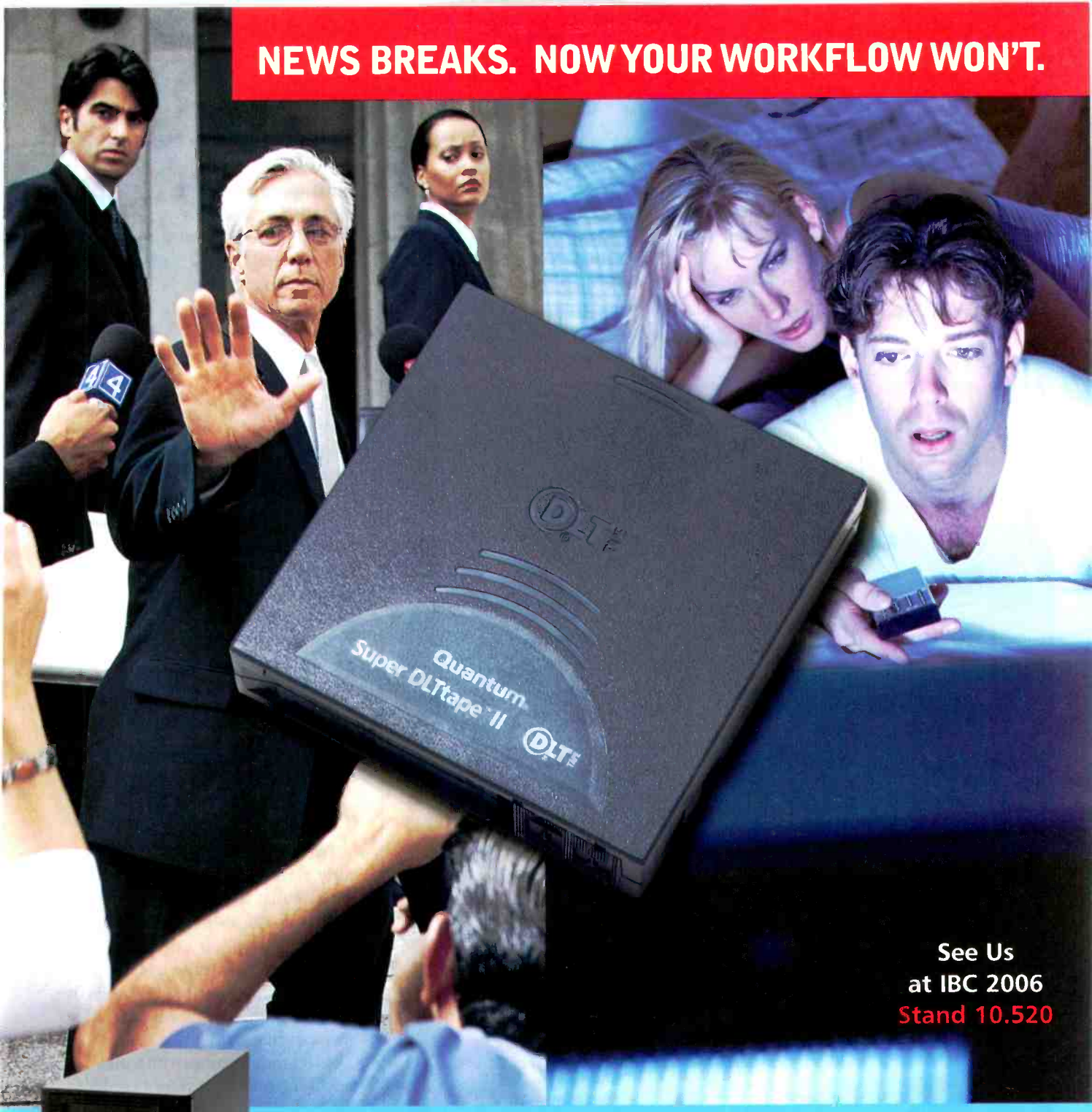

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modules in the system is a nice feature. When we access the system remotely, it's also easy to access the DA and make tweaks if there is a level loss somewhere in the plant. Again, anything that we can adjust remotely is helpful.

A typical application for FastChannel is the need to remotely test a system in preparation for an agency to get a spot to broadcaster. This involves checking for signal presence, alignment, video levels, audio levels and continuity. We call in through our keyboard video mouse, check a crosspoint and dial in the signal we want through the IP settings on the unit. We verify the signal path from the SPG to the VTR or server. Then on-site staff loads a spot and uploads it to the NOC.

Maintenance and customer service

We can access all of the cards and power supplies from the front of the frame, so maintenance is easy. For example, we can swap out a card simply by pulling the old one out and plugging in the new card while the unit is still running.

Customer support is critical. When we need help, we want to talk with a knowledgeable person right away. Ensemble Designs has always been prompt and helpful.

The company Web site has been our backup customer support system. The site offers free software updates for the cards. Software updates sometimes have new features, such as a new test pattern for the signal generator, or fixes, such as how the audio levels work.

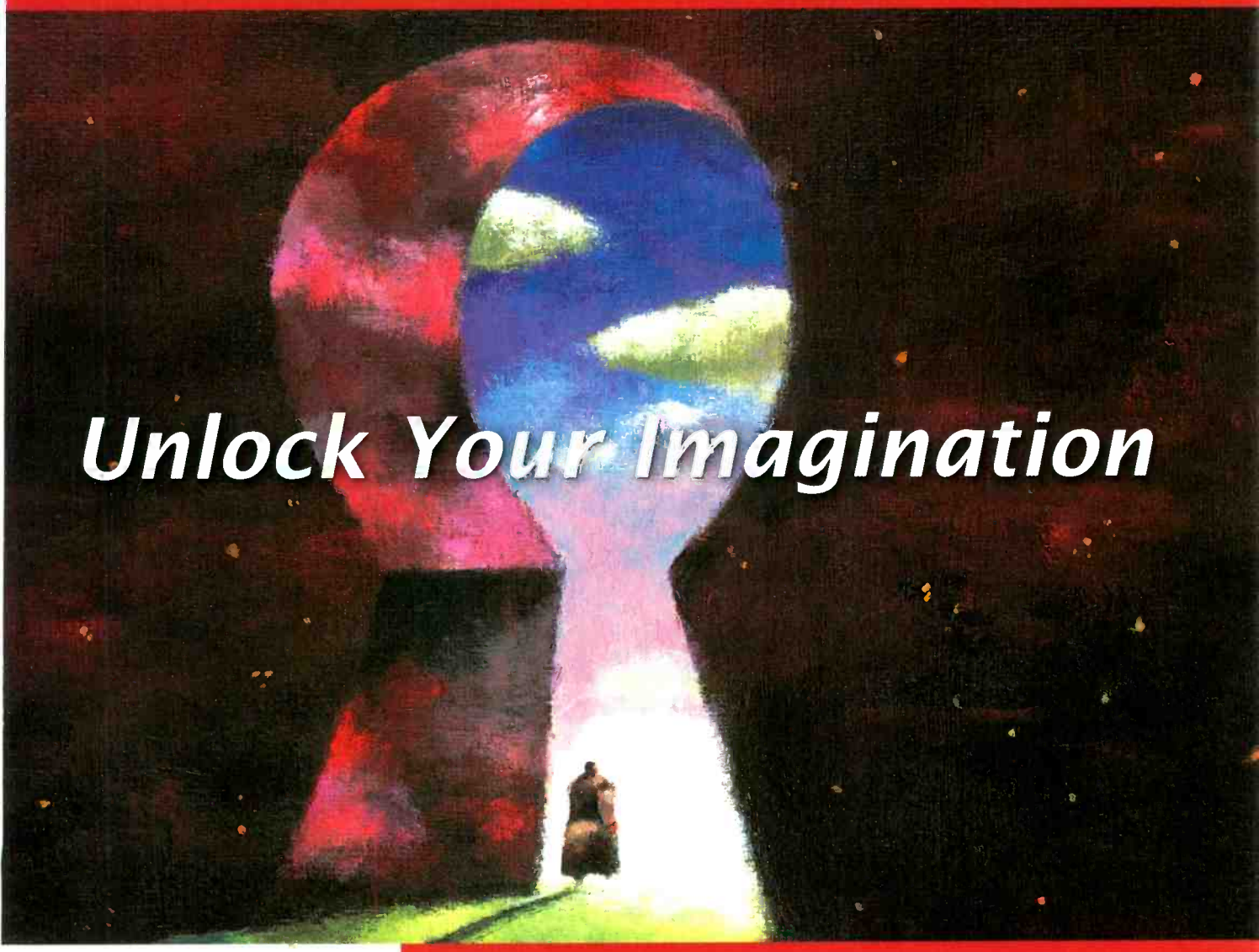
The software update process is fairly simple.

The software update process is fairly simple. The same Avenue PC software that we already use for control has a pull-down menu that allows us to update the software in a card. It takes a few minutes to get the new software into the card, and then it runs smoothly. The card is not usable on-air during an upgrade.

Each module comes with a manual, and the company provides a binder to put it in. When we get new modules, we just add the packet to the binder. But more often, we use the Avenue PC online manual for checking pinouts, because it has built-in manuals.

The user interface is self-explanatory, and we haven't had many reasons to use the manuals. The PC control software and touch screen both have pull-down menus that make everything clear. BE

Robin Shahid is the chief engineer, broadcast product specialist for FastChannel.



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SSL's C100

Is it an audio console or router? Or both?

BY JAY HARMER

In keeping with CBS Television City's policy of providing its clients with an optimum selection of modern production equipment, we recently commissioned our first primary digital audio console on a TV stage. Stage 58's primary client, "The Late Late Show with Craig Ferguson," had used a 48-input analog console for about eight years. As the show grew, this console became too small and restricted the show's ability to give guest bands a top quality sound.

In a cooperative evaluation by the mixers, technicians and management, a Solid State Logic (SSL) C100-40 digital audio console was selected as a replacement. What we found was that like modern video switchers, current audio consoles are difficult to distinguish from routers.

The console we purchased has 240 inputs and 240 outputs. They break down as follows: 72 microphone inputs and isolated outputs, 72 high-level analog inputs and outputs, and 96 digital AES/EBU inputs and outputs. So why did we need so much IO?

SSL's C100 digital audio console allows audio mixers with Studio 58 to program each fader to function as an individual channel input, a stereo input or a 5.1 mix fader.

Programmability

A prime feature of digital audio consoles is their ability to use programming to be configured differently with a single button push. This programmability includes fader layout, tracking, auxiliary sends, sub and isolated mixes, equalization, and dynamic processing settings. Just about anything that can be set can be programmed and then recalled with just a push of a button. "The Late Late Show with Craig Ferguson" uses this feature by dividing the show's production into two phases, interview and production.

For the interview segments, microphones and line inputs are arranged to enhance the mixing of that segments. When it's necessary to preproduce a production number, another fader layout is called up. With a single button, the mixer can arrange a constellation of faders that support their mixing style that is unique for that segment. Say we have a musical group; we have had as many as 26 pieces, or a small combo. In either case, the mixer doesn't have to do the grand slide from one end to the other trying to reach faders that are only occasionally used. With a programmable console, the faders most important for the current segment — along with EQ, dynamics and aux sends — can be assigned to be within easy reach.

Each fader can be programmed to function as an individual channel input, a stereo input or a 5.1 mix fader. This flexibility helps in keeping the active mixing surface small and accessible. An example is the audience reaction (AR) mix that is picked up by about eight single microphones. These faders are placed on a hidden layer and bussed to a single stereo fader on the active surface. If necessary, the layers can be exchanged and the AR mix adjusted. It is sometimes necessary to adjust this mix during the show or to isolate a section of the audience. Then with a touch of a button, the AR layer is hidden again, and the more important faders are available. In the past, this would require a separate console or the dedication of multiple faders and console real estate. Now with programmable routing, it can be accomplished at one mixing desk and the individual faders, when they are not needed, hidden.

Programmability also enhances the output routing. "The Late Late Show with Craig Ferguson" typically uses about four videotape recorders with 16 discrete audio tracks. However, when a large or complex musical group is performing, additional recorders are added. Before, the console tracking to the additional machines was limited and required patching to create a different output schedule. Now the only limitation is the number of console outputs.

Programmable output routing can be used in other ways. For instance, it can be used to send selected inputs

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to selected outputs without any fader involvement. This capability used to require the mixer to interrupt the routine just to send a short clip or production piece for recording though the main outputs.

Main electronics frame

With so much I/O, the main electronics frame looks like a large router with dense and concentrated cabling. SSL even calls is the Centri Core or, more affectionately, "the Crate." This density and the placement of connectors on both the front and back take up a lot of space. Space was also required for the service loops so that the connectors can be removed for module maintenance and to allow for the rather large turning radius of AES/EBU audio cable.

This was something we missed in our initial planning. Although we had been using AES/EBU low-capacitance cable for about 10 years, this was the first time we had so many concentrated connections. So we found that even though the electronics Crate itself is only 15RU high, we had to allow another eight or so rack units for cable access.

Like many of the compact digital boxes used today, the power supply fans make quite a racket. This means that the main electronics frame needs to be sonically isolated from the mixer. This lack of mixing desk and electronics Crate co-location means another PC for maintenance logging, separate technical power and the necessity for the operators to move to another room to use the zip drive to store or retrieve their setups.

Initially, we did not include the GPI I/O module. As we started to implement the desk into the show, we found a real need for this feature. One thing that had escaped our attention was an alarm for leaving the tone oscillator active on a non-monitored track. With so many tracking options and the necessity to identify each track, it is possible for a line-up or ID tone to be left on unnoticed. With the GPI I/O module, it would have been easy to program an alarm whenever the internal tone oscillator was left on.

Conclusion

SSL has employed a proprietary operating system, and it has been rock-solid reliable. We have been through two software, one firmware and a hardware update, and things have gone smoothly. We have had the same experience with the hardware. After a few failures in the commissioning period, the electronics hardware has been failure-free. BE

Jay Harmer is a technician at CBS Television City.

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Format conversion

Here's what to consider before purchasing a format converter.

BY JOHN LUFF

When the ATSC standard was first proposed to the FCC, many people were aghast because it included so many formats. The infamous Table 3 in Annex A lists the SDTV and HDTV standards, frame rates and scanning formats (progressive and interlace) that would be permitted in the standard. (See Table 1.)

Table 3 would have been part of the FCC Report and Order, but the FCC never adopted it, preferring instead to leave decisions about formats to "market forces." This could be viewed as a cop out, but the net effect was to allow the practical implementation of any format that consumer electronics decoders could cope with. So we have plenty of formats in use as a result.

Formats galore

One could argue that this presents no particular issue. Indeed, the FCC might say that it is only a problem for those who choose to use any particular format. However, in reality, it is an operational issue for many broadcasters, perhaps the majority.

The good news is that problems create niches to be filled, and plenty of manufacturers have leapt into the breach.

The good news is that problems create niches to be filled, and plenty of manufacturers have leapt into the breach, beginning with the obvious up- and downconverters that were available when the DTV standard was first used in 1998. Today, conversions are done in baseband and even in compressed format (MPEG).

In a practical sense, the need arises in part because we are still one foot in an SDTV world while contemplating an HDTV future. Add the fact that a significant number of television plants are still analog NTSC, and the problem gets a tad more complex.

The real kicker is that even more formats are being promulgated. Some have interest from consumers, such as 1080p, which is attractive to high-end home theater buffs. Thus, studios might shoot in 1080p60 and make copies for all release formats from a pristine master, including 1080i and 720p for common HDTV release, and 480i for NTSC broadcast. That's fine, and you might say that the conversion problem is theirs, but this isn't true.

Today, it is common for one facility to feed more than one broadcast license. For the sake of argument, let's say that one is an ABC affiliate and one is CBS. Of course, they are the two most vocal proponents of 720p and 1080i. This wouldn't be a problem if you didn't have both HDTV and SDTV spots to insert in both DTV and analog outputs. If you only consider those formats, you have up-, down- and cross-conversion needs in one facility, plus whatever analog-to-digital conversions (or the reverse) are needed.

This leaves an obvious hole. Operations personnel must not only know the format of the intended output, but also the lineage of the content so they can pick the right converter box and route the feeds. In a positive development intended to alleviate some of the difficulty, boxes exist — in several price ranges — that do each of the needed conversions available. Even better converters can auto sense the input and automatically convert to the intended output format. Some will provide both HDTV and SDTV outputs at the same time, taking much of the burden off of a busy operations staff.

Vertical size value	Horizontal size value	Aspect ratio information	Frame rate code	Progressive sequence
1080[1]	1920	1, 3	1, 2, 4, 5	1
		4, 5	0	
720	1280	1, 3	1, 2, 4, 5, 7, 8	1
		1, 2, 4, 5, 7, 8	1	
480	704	2, 3	4, 5	0
640	1, 2	1, 2, 4, 5, 7, 8	1	
		4, 5	0	

Legend for MPEG-2 coded values					
Aspect ratio information	1 = square samples	2 = 4:3 display aspect ratio	3 = 16:9 display aspect ratio		
Frame rate cod	1 = 23.976H	2 = 24H	4 = 29.97Hz	5 = 30Hz	7 = 59.94Hz 8 = 60H
Progressive sequence	0 = interlaced scan	1 = progressive scan			

Table 1. ATSC Table 3 compression format constraints. Courtesy ATSC. [1] Note that 1088 lines are actually coded in order to satisfy the MPEG-2 requirement that the coded vertical size be a multiple of 16 (progressive scan) or 32 (interlaced scan).

Cost considerations

But before you can pick the necessary converter, you should carefully

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consider the requirements that need to be satisfied and the expected performance from the device. It is not appropriate to pick converters by price alone (either by buying cheap or unnecessarily spending money on an all-dancing bear). There are silicon scalar solutions available that can be used to build complete converters that convert both directions for less than $5000. They do a good job and are perfectly credible for many applications. They are generally limited by the quality of the filtering done and feature set available. Some have been built into standalone boxes, which might be mounted on a panel, such as a monitoring converter. They offer somewhat limited operator controls, though via serial interfaces, full control is possible.

Choosing such a device for primary use may be appropriate in smaller markets where price is a primary driver in the decision. However, in a large station or major production center, a more complete and full-featured solution is usually needed. In addition, these "Cadillac" solutions may offer superior filtering. Indeed, some manufacturers tout filtering as a defining difference in their high-end products. For some applications, this can be true.

Other features to consider

Consider the operator interface as well. Some products are intended for remote mounting and computer control. Others have full controls on the front panel and/or offer remote control panels designed for the device. In a master control room environment, it may not be appropriate to have an additional computer screen for controlling the operation of conversion equipment. But if that control can be combined in a system that offers SNMP monitoring of servers and other terminal equipment, it may be justified.

Aspect ratio conversion is normally part of the feature set of these converters. With the rise in the number of changes between 4:3 and 16:9 programs and interstitials, there will come a time in the not too distant future when automatic switching back and forth will be desirable (and likely carried in the information passed by traffic to the automation log).

Look for a system that can accept a command to change aspect ratio as needed. Presets that accommodate the look you normally prefer are a great feature. For instance, today you might want to letterbox a 16:9 program on the NTSC channel, but run commercials full-screen, with the reverse on NTSC. In the future, you may want to convert all content to 16:9 when NTSC shutdown happens (or whenever your audience has a high percentage of wide-screen displays).

Lastly, audio concerns should be taken into account. Video processing engines, such as these complex scaling engines, create latency in the picture content. When implemented, matching audio delays must be planned. Many conversion solutions offer this internally.

If you are using embedded audio, be sure the device you pick can accommodate it. Check with the manufacturer to ensure multichannel audio on AES (Dolby AC3 and Dolby E) will pass through unmodified. If you have discrete levels of audio to handle multichannel sound, be sure all channels will pass through the solution. It's also important to ask the manufacturer if both SD and HD inputs are handled the same way. BE

John Luff is the senior vice president of business development for AZCAR.

? Send questions and comments to: john_luff@prismb2b.com

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+44 1962 777733
www.brickhousevideo.com

Bluefin — Calrec Audio

High-density signal processing is now available on the Sigma digital console; enables the desk to handle 320 fully-equipped mono equivalent channels, packaged as 108 stereo and 104 mono, and configurable up to 52 full 5.1 surround channels; gives the Sigma the same bussing capabilities as the Alpha console, including 20 auxiliaries and 48 multitrack outputs; allows operators to introduce 19.6 minutes of audio delay.

+44 1422 842159; *www.calrec.com*

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207-655-8100; *www.dielectric.com*

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631-845-2133; *www.chryon.com*

PT5300 — DK-Technologies

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+45 44 85 02 55
www.dk-technologies.com

VIPS 3000 series — Dayang

The multi-definition server provides simultaneous output of HD and SD signals; HD ingest and playout can be performed in MPEG-I, MPEG-IBP and DVCPRO HD formats; SD ingest and broadcasting of files in DV25, DV50, MPEG-I and MPEG-IBP formats are supported; available in three versions: VIPS 3412 (one input, two outputs), VIPS 3423 (two inputs, four outputs) and VIPS 3404 (four inputs, four outputs).

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201-392-4127
www.panasonic.com/broadcast

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905-335-3700; *www.evertz.com*

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Built on Genelec's 8000 MDE and 7000 LSE series products; the new 8200 series bi-amplified active monitors and 7200 series active subwoofers are designed for end users who want a network speaker system that can be set up, measured, analyzed and calibrated quickly.

508-652-0900; *www.genelec.com*

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973-575-7811; *www.evs.tv*

CanalettoMDi — Eyeheight

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+44 1923 256 000
www.eyeheight.com

Newscaster DR — Nucomm

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

vsnscenes — JustEdit

The low-cost newsroom editor allows low-resolution proxy preview in variable speeds directly from the chosen format (XDCAM or P2) and selection of a list of clips or subs; automatically uploads high-resolution content to shared video servers; enables management of associated metadata, creating and importing EDLs and selection MXF for transcoding the selected high-res files.

+34 937 349 970; *www.vsn-tv.com*

LV5800 — Leader

The multi-monitor platform can be configured on a modular basis to meet specific HD/SD signal analysis requirements while allowing easy future expansion; it retains the intuitive user interface of the LV5700 and LV5750; major options include twin auto-detecting inputs, 1080p/50 dual-link, ultra-compact detachable front panel and data capture to standard USB memory pen.

+31 40 2 645 345; *www.elquip.com*

SDI-IP-GTW — Network Electronics

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800-420-5909
www.network-electronics.com

iTX — OmniBus

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704-319-2231; *www.omnibus.tv*

SDLT 600A — Quantum

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719-536-5263; *www.quantum.com*

Morpheus — Pro-Bel

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925-735-9269; *www.pro-bel.com*

Quasar — Snell & Wilcox

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212-481-2416; *www.snellwilcox.com*

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513-459-3400
www.broadcast.harris.com/leitch

TRX900 and TRX990 — Zaxcom

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973-835-5000; *www.zaxcom.com*

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781-221-7400; *www.volicon.com*

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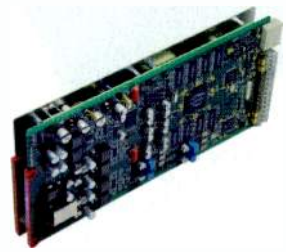

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MAINTENANCE ENGINEER

The Oklahoma Public Television Network seeks skilled applicants for Maintenance Engineer for KOED/Channel 11 in Tulsa. A successful candidate must have a minimum of 2 yrs experience in maintenance, troubleshooting and repair of broadcast equipment. SBE Certification or equivalent education and experience preferred. Must be able to kneel, lift & carry equipment weighing a minimum of 50 lbs. Must be able to climb ladders as in performing required job task. Send resume to OETA, attn: HR, PO Box 14190, Oklahoma City, OK 73113. Applications are online at www.oeta.onenet.net. OETA is an AA/EOE employer.

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TURN BACK THE CLOCK TO FIVE MINUTES BEFORE CONSOLIDATION

It's hard to believe, but there IS a place that still believes in local radio which serves the needs of Main Street instead of Wall Street. It's a place where radio can still be done in a non-corporate, creative environment. It's a place where the owner does not believe in the three "U B's" (Unrealistic Budgets, Uninspiring Bosses and Unbelievable Beatdowns). It's a place where the owner still believes that magic, passion and possibilities are the cornerstone of the Radio business today, AND tomorrow. It's in Chicago, at Newsweb Radio Company.

My name is Mike McCarthy, and I manage the engineering at 9 stations in the Chicago area. Somehow, I know there is an engineer somewhere who still feels the same way that I do. I am looking for that person to join me. If you live and breathe engineering, love to get your hands dirty as much as you hate to do paperwork, still believe that engineering is in the field as opposed to behind a desk and you want to do it in a non-corporate environment, we should talk. I don't care about your current market size, shape or where you are at now. I do care that you are experienced in AM/FM RF as well as having experience with computer networking and automation ystems. I don't care about your experience ... I care about your expertise. If these things are important to you, email your resume and salary history to me at **mmccarthy@9chicago.com**. We are an equal opportunity employer.

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This position will oversee the operation and maintenance of television studios and studio equipment to include monitoring the installation, calibration, operation, and maintenance of cameras, video switchers, monitors, audio mixing equipment, lighting controls, and other broadcast studio equipment. In addition, this position will supervise five operator/technician staff members and will oversee master control switching, satellite recordings, videotape duplication, and the transcoding of incoming digital and analog signals.

Other duties include: designing and modifying systems and equipment to increase efficiency and economy of operation; preparing drawings, schematics, diagrams, written specifications, and justifications; providing hands-on technical and operational expertise; and creating and maintaining an appropriate engineering infrastructure to support the U of M.

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The HDMI future

Vendors — not broadcasters — are leading the way.

BY PAUL MCGOLDRICK

In the history of television, broadcasters have always led development — both with their own internal research and development and by persuading manufacturers — to produce the necessary equipment to create, process and transmit video and audio for consumers. However, things have changed — with a vengeance.

In December 2002, a consumer vendors group (comprising Hitachi, Matsushita Electric, Philips Electronics, Silicon Image, Sony, Thomson and Toshiba) announced the base specifications for a new standard called the High-Definition Multimedia Interface (HDMI). Silicon Image was also a member of the group that developed the Digital Visual Interface (DVI).

HDMI was conceived as a standard interface for connecting any piece of equipment operating with uncompressed digital video and audio signals. It replaces the mess of cabling that can often be found in the homes of those who are in tune with modern audio and visual electronics. With a standard connector interface, both digital video and audio can remain in the digital world as they pass in this serial format between different boxes. This also avoids the inevitable degradation of signals as they are converted to analog for interfacing and then reconverted to digital formats in the next piece of equipment.

From day one, the HDMI standard has allowed for up to eight channels of audio and 24-bit 192kHz sampling and has been compatible with all the ATSC HD video standards. Although it has not yet entered the majority of homes, HDMI is the future de facto digital interface system for the consumer vendors.

The original version (1.0) was followed by a working 1.1 standard in May 2004. It was later upgraded to version 1.2 in August 2005 to include features such as one-bit audio. Version 1.3 has now been released, and its vision goes way beyond anything that broadcasters have even dreamt about, let alone considered for implementation. For example:

- The single-link bandwidth has increased from 165MHz to 340MHz.
- From the previous support of up to 24 bits of color depth, support has now been added for 30-bit, 36-bit and 48-bit color depths in either RGB or YCbCr.
- It now supports lossless compressed digital audio formats such as Dolby TrueHD and DTS-HD Master Audio.

Apart from allowing higher resolutions and frame rates way beyond today's consumer needs, the number of colors that will be available has increased to about 16.7 million, more than double the 7 million that the human eye can discern. But the availability of that range makes it possible to finally remove the banding effect that can be so obvious as a color slowly transitions across a display. The HDMI founders call this Deep Color.

The new standard also allows a mini connector to be used in small, personal photo and video devices. And, probably the best news in the whole specification: Automatic lip sync correction is available! Competing audio delay ICs, such as Texas Instruments' TPA5050, will attempt to fill that role.

There are reportedly 400 consumer manufacturers that have adopted HDMI, and analysts predict that 60 million HDMI-equipped devices will ship in 2006. The licensing program for adopters calls for an annual payment of $15,000 plus 15 cents for each shipped product, which reduces to 5 cents if the HDMI logo is clearly displayed on the product. It reduces another cent if you're also paying Intel for its HDCP content protection.

All HDMI 1.3-specified products are backwards compatible with earlier products. And when you plug in a new product, the system automatically configures itself to suit.

Using regular copper cable, long runs can be made, and when I am in the market to replace my analog interfaced equipment, I will certainly go the HDMI way. Maybe then I can take all those RCA cables and turn them into a work of art. BE

When I am in the market to replace my analog interfaced equipment, I will certainly go the HDMI way. Maybe then I can take all those RCA cables and turn them into a work of art.

Paul McGoldrick is an industry consultant on the West Coast.

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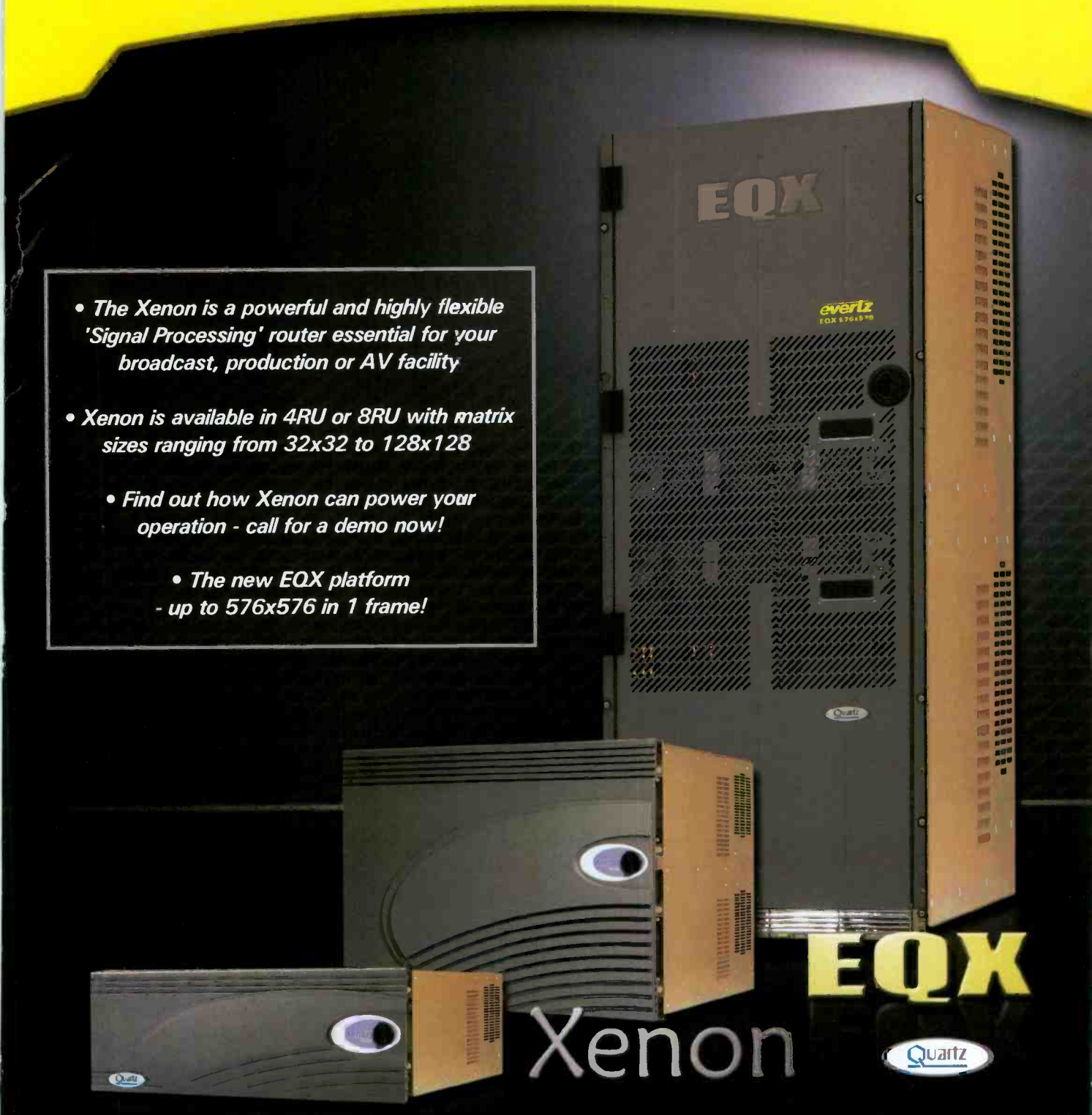

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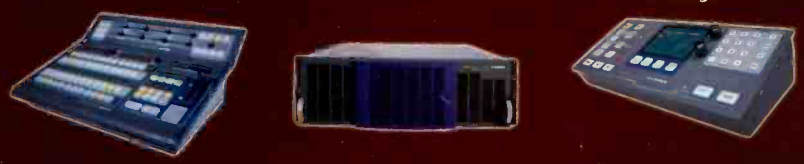

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