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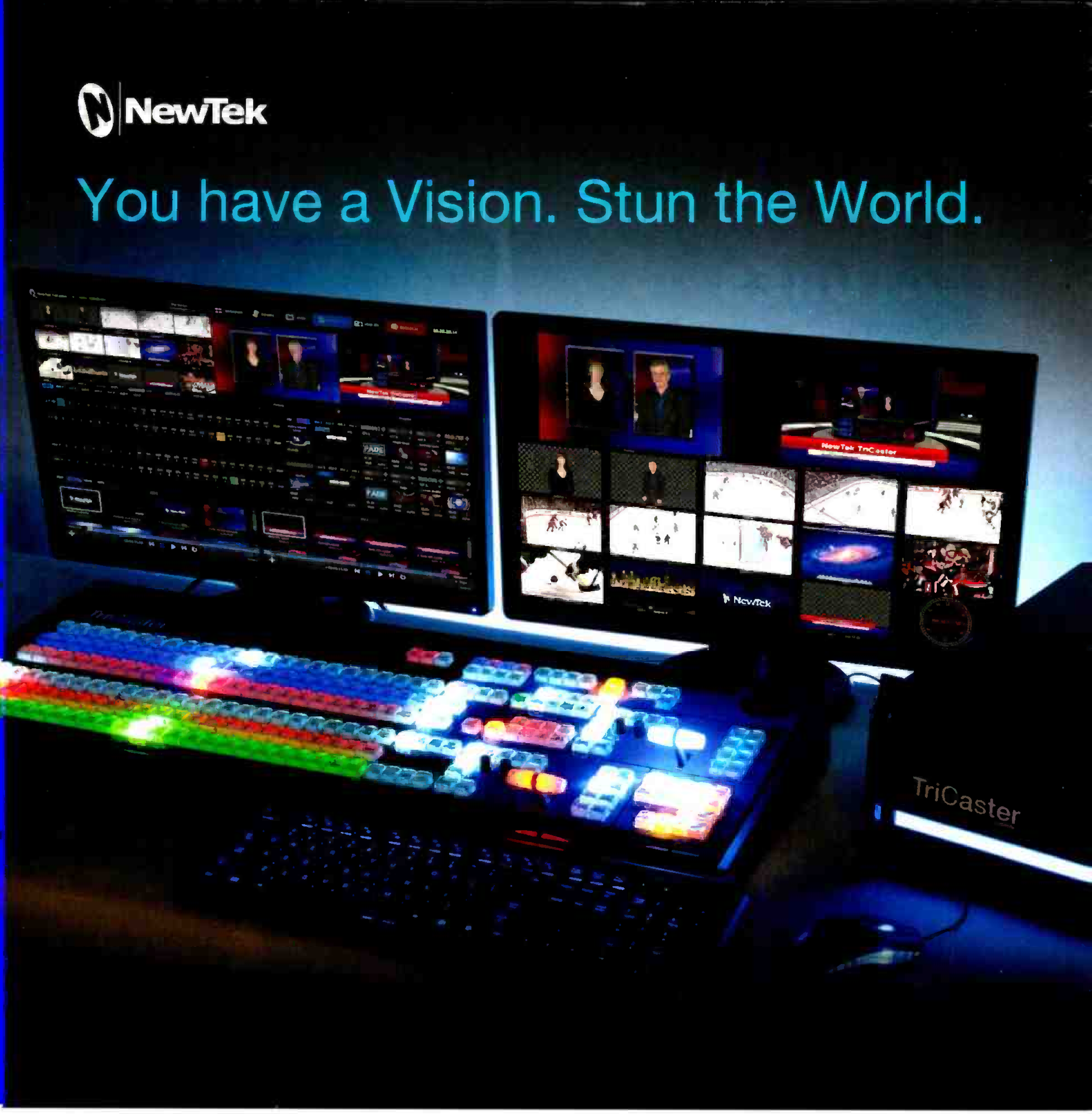

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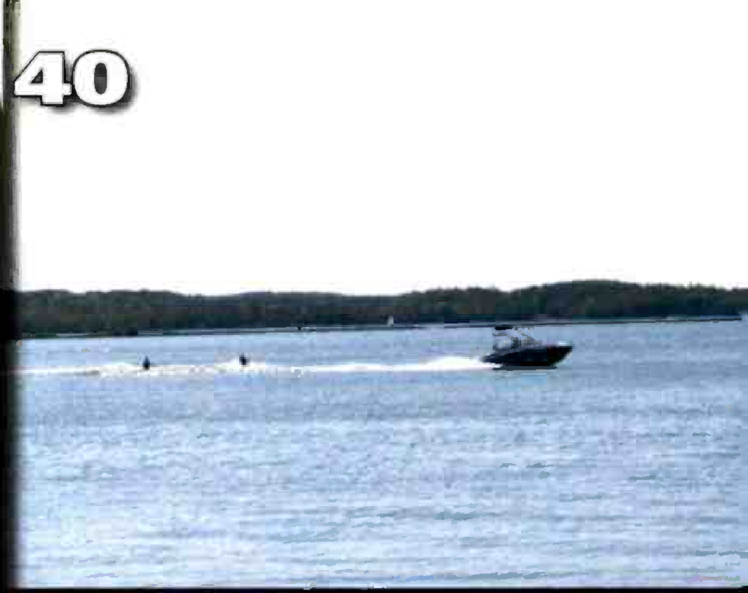

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When CBS Sports Network executives set out to build a new studio for the network, they had to take into account production for dozens of studio shows, original programs and more than 350 live games. Photo courtesy CBS.

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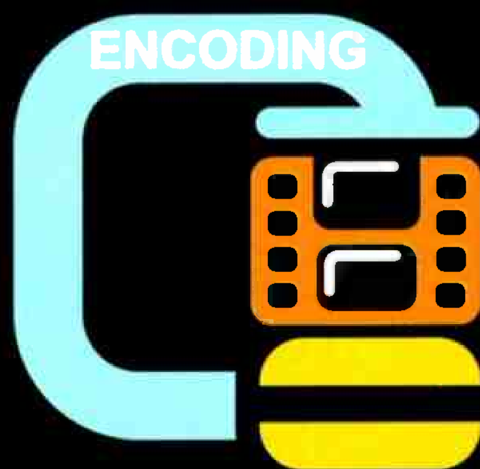

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HDTV on steroids

In late October, the Consumer Electronics Association (CEA) begins the drum beat about innovation, new technology and, of course, new products. The noise is all focused on the association's upcoming Consumer Electronics Show in January. It's often hard to discern real product technology from all the smoke and mirrors as vendors scramble for attention. Although the event is titled "Consumer," broadcasters should often take heed as the last two broadcast-related innovations originated at that show — digital/HDTV and 3-D. One worked; the other, not so much.

This year's convention ramp-up is symbolized by the association's annual "Five Technology Trends to Watch" report. In the report, the CEA predicts five technologies that will soon affect consumers. This year's report includes one that will affect *Broadcast Engineering* readers — super high-resolution video displays.

A 4K TV is "the HDTV experience on steroids," says John Taylor, vice chairman of CEA's 4K Working Group and vice president of public affairs and communications at LG Electronics USA. Taylor's committee is charged with evangelizing 4K technology, which "gives manufacturers and retailers alike another opportunity to attract a high-end customer" with super large-screen TV sets.

However, not so fast says Jon Peddie, president of Jon Peddie Research. Even for those early adopters, he says, "the tricky part" with 4K is that there needs to be content. "That's going to be the barrier more than the price or the technology," he says. Peddie also notes that has been the problem for "stereovision" or 3DTV, for which there remains "insufficient content to keep viewers happy."

"Indeed, there is no 4K content available today," Taylor agrees. But, "Blu-ray 4K material is not too far off. And, with innovation in the video compression arena, you'll see 4K delivered over the Internet, through cable and even through over-the-air broadcast television." The CEA predicts broadcasters will be using ATSC 3.0 in "in eight to 10 years."

Chris Chinnock, president of Insight Media (a market research and consulting firm focused on emerging display technologies), says, "Most people are going to look at their TVs and say, 'It looks really good and crisp to me. Why do I need 4X as many pixels?' And, the answer is, from a visual acuity point of view, you probably don't."

Chinnock continues, saying, "Most people are not going to see a difference — certainly not under a screen size of 50in viewed from a normal living room viewing distance." It will be on home screens — 60in and larger — where the benefits of a 4K image will be apparent. And, according to Chinnock, "the trend is to bigger screens."

The CEA estimates that while only 20,000 4K TVs will ship in 2013, the number sold will rise to 190,000 units in 2014 and 1.3 million units in 2015.

As with many consumer products, the real driving force is not just technology improvements, but an industry looking for the next shiny object to wave in front of consumers and separate them from their hard-earned cash.

A 4K consumer study done last August showed only 26 percent of survey respondents said they were interested in 4K technology, while 49 percent were not interested and 25 percent were undecided.

Before we push back, recall that many engineers laughed when HDTV was first introduced. (It was too big and expensive; digital quality was sufficient.) Then, we had those HD camera displays locked on rotating Geisha dolls. That was early HD, and many engineers said no one would pay $10,000 for a TV set, even if the picture was sharper. Well, some viewers did, and, thanks to technology, a 40in HDTV today costs less than $300.

So too will be the path of 4K. **BE**

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

Content preparation for adaptive-bit-rate video

Target devices will drive packaging decisions.

BY JOHN PALLETT

Today's media landscape is radically more diverse than just a few years ago. The delivery of consistently acceptable image and sound quality is taken for granted by viewers, despite uncertain or fluctuating bandwidth. Adaptive-bit-rate (ABR) streaming technology makes this possible.

What is ABR streaming?

ABR streaming is a delivery technology designed to provide consistent, high-quality viewing in situations where bandwidth may fluctuate, and where viewers may be on a wide range of devices.

Prior to ABR streaming, Web or mobile video delivery was typically done by encoding a single downloadable file or stream at a fixed bit rate and frame size. Viewers could buffer some of the video, and then simultaneously download and play it back. This delivery model was similar to cable transmission, where a single bit rate is transmitted over a reliable medium.

Unfortunately, transmission mediums for Web and mobile devices are unreliable, and bandwidths vary. During fixed-rate video playback, viewers with low bandwidth suffer from excessive buffering (delaying playback). To compensate, providers have tended to encode at lower bit rates, punishing viewers with high bandwidth. Even then, any fluctuations in bandwidth can cause buffering delays.

To solve this problem, ABR streaming content is encoded into multiple layers, each potentially a different bit rate, frame size and/or frame rate. These layers are combined into a single package that represents the original content. ABR players switch between layers depending upon the device and available bandwidth, to ensure consistent high-quality playback.

ABR streaming is ideal for mobile and Web video delivery.

For example, a single ABR package might include six layers, each encoded at progressively higher bit rates. As a viewer watches content on his/her mobile phone during a train ride, the player will adaptively switch between low bit rates and high bit rates, depending upon the connectivity of the device.

How does it work?

Most ABR streaming technologies use standard Web protocol (HTTP delivery) to send video. This offers advantages over specialized streaming protocols such as RTSP or RTP, as HTTP-based delivery works immediately on Internet networks and can take advantage of edge technologies designed to cache HTTP requests.

During playback, video and audio are delivered via HTTP in small fragments, each representing some small amount of video, typically between 3 and 10 seconds in length. Each content package includes multiple layers, and each layer may include many fragments. For example, an hour-long movie may have 12 layers, each with a thousand fragments. The player is provided with a package manifest file outlining which layers are available and the location of the fragments for each layer.

During playback, the player requests and downloads a fragment from a layer. While the fragment is played, the connection speed is monitored, and the player may opt to switch layers, either increasing or decreasing the video bit rate based upon the connection speed. Players may also choose layers with different frame sizes or frame rates to optimize the visual experience for the device. This adaptive behavior is what ensures consistent playback regardless of connection speed or device.

There are several different ABR streaming technologies available: Apple HTTP Live Streaming (or "Apple HLS"), Adobe HTTP Dynamic Streaming (or "Adobe HDS"), Microsoft HTTP Smooth Streaming, and more recently MPEG Dynamic Adaptive Streaming over HTTP (or "MPEG DASH"). Each technology requires a complete ecosystem. The content must be prepared correctly, and the correct player must be used. All of the technologies work fundamentally in the same manner, using HTTP for content delivery in fragments.

Where these technologies differ is largely related to the structure of the underlying packages. For example, HLS for older versions of iOS requires a separate file for each video fragment. In contrast, most other packages store fragments for a layer in a single file, allowing the player to download fragments using HTTP byte range requests, which download a small part of a larger file.

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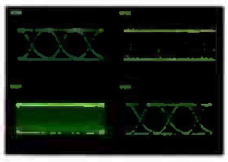

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Other differences in ABR technology relate to the viewer experience. Apple HLS, for example, provides for a dedicated key frame layer, allowing users to scrub through the video quickly. Other packages allow an audio-only stream with a poster image for extreme low-bit-rate situations.

Preparing content

Preparing ABR content takes several steps. First, the desired packaging and layer structures need to be identified. Next, content must be encoded, checked for quality, packaged, encrypted and delivered. (See Figure 1 on page 14.)

Choosing packaging and profiles

Packaging choice is generally driven by what devices must be supported. Not every device supports players for every type of ABR streaming technology. As a result, one should catalogue both the devices and the players that will be supported. The necessary packaging will naturally become apparent as a result.

The selection of optimal bit rates, frame sizes and frame resolutions will vary depending upon device types, connection types and encoding technology. Apple and Adobe provide excellent starting points with suggested profiles suitable for their ecosystems. However, practically speaking, the entire catalogue of devices, expected network connections and network costs must be considered when designing layers.

With these considerations, layer design is a balancing act between frame size, bit rate and quality. However, the actual encoding technology used may have the biggest effect upon quality. For example, one study performed by the MSU Graphics & Media Lab showed that the use of x264 encoding technology saved necessary bit rates by as much as 50 percent compared to other H.264 encoding technologies at the same quality level. As a result, it is recommended that layers be designed while performing actual encoding tests with the final encoding technology.

Most packages, however, generally contain between 16 and 24 layers. Part of layer design will require a reduction in the number of layers. It is best to select a few common native display frame sizes (such as 1080p) and then encode multiple bit rates to those frame sizes. Doing so will avoid unnecessary performance degradation on players that use software scaling (particularly important for Adobe HDS).

Encoding, packaging, delivery and DRM

Each layer will require that a complete H.264 stream be encoded. With 16 to 24 layers, encoding an ABR package can easily require 20 times the processing power needed for a single H.264 stream. Fortunately, highly parallelized multirate H.264 encoding technology exists that re-uses information across the different streams. When combined with GPU acceleration, today's encoding systems can offer 10 or 20 times the speed of CPU-based systems.

When preparing for multiple devices, an important aspect of encoding is transmuxing, the ability to re-use

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encoded H.264 streams across multiple package types. This prevents having to re-encode the same bit rates simply to package the video differently.

With on-demand content, it is important to perform QC checks on the different video streams. QC may be performed visually or by using automated tools that measure quality across all of the streams.

On-demand content often requires user authentication and protection prior to playback, which requires digital rights management (DRM). When using DRM, the video must be encrypted during packaging, typically using AES 128-bit encryption. DRM systems typically have subtle requirements for how the encryption is performed by the encoder or packager, and it is important to validate that the two are compatible.

Finally, content delivery will be performed, either as a compressed TAR file or in the native package form. Where possible, it is recommended that the entire production process (ingest, encoding, transmuxing, packaging, quality control, encryption and delivery) be combined into a single automated workflow. Manual steps will significantly slow production time and may result in errors. It is also recommended that the ABR production process be combined with non-ABR production into a single automated system. This reduces system maintenance costs, offers a single view into the overall content production for all distribution channels and allows workflow efficiencies such as unified metadata preparation and content preprocessing.

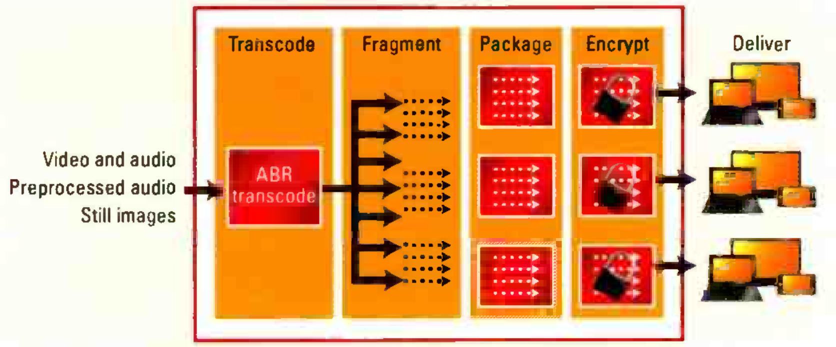

Figure 1. ABR production workflow

Conclusion

Preparing video for ABR streaming generally requires research up front to choose technologies and encoding profiles, and a well-integrated, accelerated encoding approach to ensure workflow efficiency. With today's tools, it is possible to fully automate the ABR content production workflow with full integration into existing content preparation and delivery workflows. BE

John Pallett is director of product marketing, Telestream.

New online public file system

Securing stations' passcodes is essential.

BY HARRY C. MARTIN

The FCC's online public inspection file system for television (including Class A) licensees became effective in August. For the majority of stations, the new system has thus far been largely a non-event. That's because the primary impact of the new system, at least initially, has fallen on a relatively small universe of stations — *i.e.*, affiliates of ABC, CBS, NBC and Fox in the top-50 markets — who have had to upload all new political-file materials. Stations in smaller markets, even those affiliated with the top-4 networks, do not have to upload political files until 2014.

However, the public-file rule requires that licensees in all markets upload *newly created* public-file materials (except political materials as noted) on the FCC public-file website. The first such universal public-file upload deadline — for the third-quarter issues/programs lists — was Oct. 10, 2012.

The FCC has imposed a two-tiered system for access of stations' online public files. The FCC has created a system of public-file passcodes that can be set up by each licensee and then distributed to station personnel. The licensee's FCC Registration Number (FRN) and FRN password are used to set up the passcode, but to allow staff to upload materials without sharing sensitive FRN password information with them, only the passcode is needed to access and manipulate the file.

To actually get into its own public file for uploading purposes, a licensee will need to know the station's FCC Facility ID Number (FIN) and its separate online public-file passcode.

Securing passcodes

The FCC has designed the system with security in mind. Presumably, at the station level, there will be at least several staffers who will be responsible for getting the necessary materials uploaded. Obviously, each of them will need to have access to the necessary passcode. But it is important that access to passcodes be limited to those staffers who can be trusted to keep them secure.

If an employee familiar with the code leaves the station's employ, licensees may want to make sure that his or her access to the file is immediately terminated. All the licensee has to do is enter the station whose passcode it wants to change into the system, and click on the "Generate New" button at the bottom of the station's information list. The public-file system will immediately give the licensee a new passcode for that station.

The commission's system does not permit licensees to designate their own passcodes.

The commission's system does not permit licensees to designate their own personalized passcodes. The apparently random passcodes generated by the FCC's system are likely far more secure than whatever a licensee might select.

Under the former public-file system, anyone trying to remove materials would have had to deal with the physical barriers of personnel and locked file cabinets. Under the new online system, a raider needs only two pieces of information — the station's FIN and its passcode — to get into the file from anywhere, any time of the day or night. The FIN is easily obtainable through the FCC's Consolidated Database System (CDBS), so protecting your passcode is the key to making sure no one deletes or otherwise manipulates your file.

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

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

Dateline

- On Dec. 1, 2012, television and Class A TV stations in Arkansas, Louisiana and Mississippi must begin their pre-filing renewal announcements in anticipation of filing their renewal applications on Feb. 1, 2013.
- On or before Dec. 1, 2012, noncommercial TV stations in Alabama, Connecticut, Georgia, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont must file their biennial ownership reports.
- On or before Dec. 1, 2012, television stations, Class A TV, LPTV stations and TV translators in Alabama and Georgia must file their license renewal applications.
- On Dec. 1, 2012, television and Class A TV stations in the following locations must post their 2012 EEO reports on the FCC's new public-file Web page and on their own Websites: Alabama, Colorado, Connecticut, Georgia, Maine, Massachusetts, Minnesota, Montana, New Hampshire, North Dakota, Rhode Island, South Dakota and Vermont.

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Automation & Media Management

Multiplexing

New multiplexing technologies are emerging, offering significant gains in bandwidth efficiency.

BY ALDO CUGNINI

Having previously discussed aspects of multiplexing in this column, this month we'll consider the technology in broader terms. In general, multiplexing is the process of transmitting multiple signals within a common channel, with the purpose of using a shared medium. On the receiving end, a demultiplexer (demux) extracts the individual signals that were originally combined in a multiplexer (mux).

Multiplexing basics

Multiplexing can increase channel utilization by multiple programs or optimize channel use by a single program, or both. The amount of bandwidth needed to transmit a multiplex must be higher than that of the constituent signals (usually a straight sum of the individual bandwidths, plus any additional overhead), although the increase may be offset by means of information-reducing techniques, such as compression.

So the usual goal of multiplexing is not to save bandwidth, but to use it efficiently and to share a common, typically scarce or expensive, medium. It is also possible to split a single source signal into multiple lower-rate signals, transmit those and then perform the inverse function at the receiving end — a process called Inverse Multiplexing (IMUX).

Multiplexing can be divided into three general types: time domain, frequency domain and spatial domain. Time Division Multiplexing (TDM) is essentially the time-based switching of multiple analog or digital input signals. In the digital realm, we can extend the utility of TDM to that of switched information packets within larger streams. With the ubiquitous MPEG standards, packets of information (each potentially carrying different content) are multiplexed within a program stream or transport stream, and statistical multiplexers (stat mux) can dynamically adjust the amount of bandwidth needed by each constituent program within a larger stream, making for efficient use of a limited-bandwidth "pipe."

So the usual goal of multiplexing is not to save bandwidth, but to use it efficiently and to share a common medium.

Other forms of content distribution use multiplexing, too. Within storage devices or information streams, multimedia files can combine various video, audio and data components into one package or file format, forming a pre-multiplexed container. Ethernet is another TDM means for carrying multiple packets from and to different destinations using a common cable, often with routers (another form of multiplexer) along the way. And, pixel-based displays use multiplexing order to minimize the number of interconnections to the display-driving transistors.

Frequency Division Multiplexing (FDM) is widely used in broadcasting and networking. FDM involves the use of multiple carriers to transmit multiple signals over a common medium, usually cable or wireless spectrum. This involves the process of modulation, whereby the information signal is impressed onto the carrier signal.

One common form of FDM is Orthogonal FDM (OFDM), used for DVB-T, DSL modems and various 802.11-based wireless local area networks. Another variation of FDM is Wavelength Division Multiplexing (WDM), which places information onto multiple optical carriers within a beam of light carried in free space or over an optical fiber.

Spatial Division Multiplexing (SDM) is a technique whereby multiple RF signals occupy the same bandwidth (or carrier frequency), but in a different physical space. Cross-polarization is one long-established variety, whereby independent signals are transmitted on the same carrier frequency by using orthogonal electric field vectors, commonly referred to as horizontal and vertical. When received by orthogonal antennas, the two signals can be separately detected and demodulated. In addition to placing two signals on orthogonal planes, the carriers are often displaced by 90 degrees of electrical phase shift as well, resulting in Circular Polarization (CP), which has been shown to alleviate some of the effects of multipath interference.

Another form of SDM exploits a characteristic called Orbital Angular Momentum (OAM), which operates by placing separate signals on multiple elements of a specially constructed helical antenna. Sometimes called "twisted radio beams," OAM emerged from research in optical communications and is different from CP. With CP, the electric field vector rotates in space, whereas with OAM, the wave front rotates. OAM signals

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have been generated by using antenna arrays consisting of concentric uniform circular arrays, with the antenna elements in the arrays fed with a successive delay from element to element. Although OAM is believed

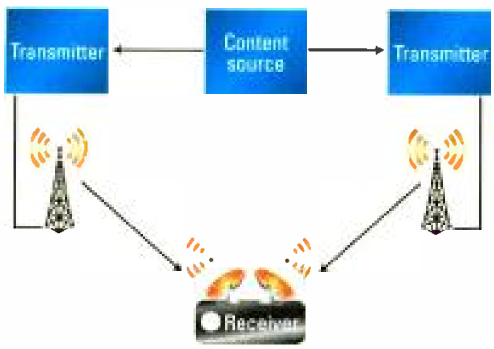


Figure 1. MIMO uses multiple transmitting and receiving antennas, all operating on the same frequency or in the same channel.

by some to offer substantial gains in bandwidth efficiency, others remain skeptical, describing it as a subset of Multiple-Input-Multiple-Output (MIMO) at best, with equivalent properties and no added advantage.

Emerging technologies

New multiplexing technologies are also emerging. MIMO is an SDM technology that increases transmission capacity by using spatially separated transmission antennas together with spatially separated receiving antennas. Currently used in 802.11n wireless technology, MIMO works by splitting a source signal into several lower-rate components and transmitting those components in the same frequency channel from spatially separated antennas, as shown in Figure 1. The transmitters radiate into the broadcast area on the same frequency, and multiple antennas are used to receive the transmitted signals, which arrive from different directions. (Note that the input/output terminology refers to the "air" medium, and not the source or destination equipment.)

MIMO technology is based on an earlier concept called Distributed-Transmit-Directional-Receive (DTDR). In some respects, the Single-Frequency Network (SFN) and distributed transmission modes of digital terrestrial television share similarities with MIMO, the key difference being that multiple receive antennas are not used with digital transmission systems such as DVB and ATSC.

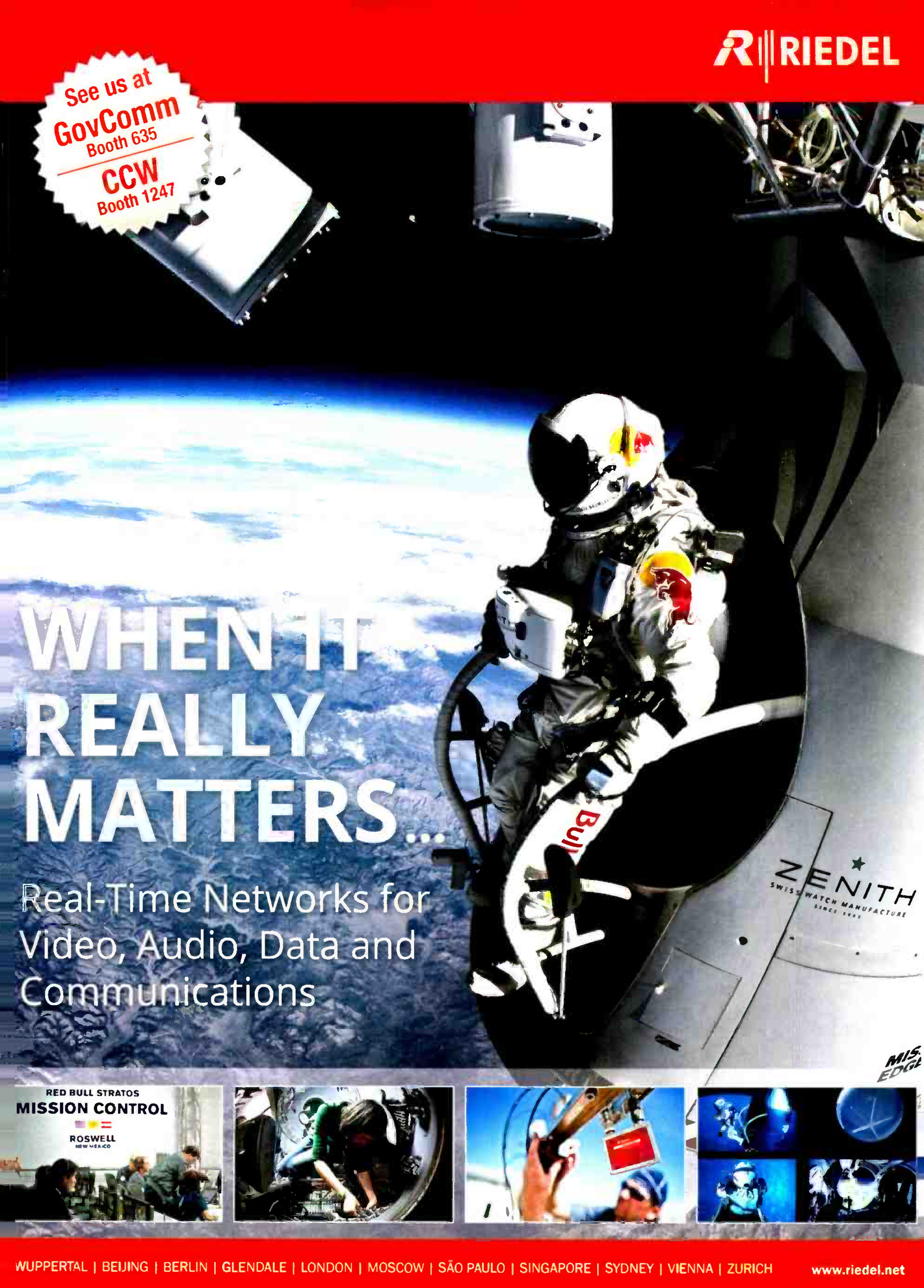
MIMO is not diversity reception, which uses multiple receiving antennas to combat multipath, but only one transmit antenna. Nor is it a directional array, which uses multiple transmitting antennas to generate a directional transmission pattern. And is not a combination of both.

One intriguing aspect of MIMO technology is the ability to operate in a closed-loop fashion, i.e., with feedback. When one-to-one communications are used (such as for unicast and peer-to-peer links) and a return channel is available, receivers can send, back to the source, channel information regarding scattering, fading and power decay with distance. This information can then be used by an intelligent transmitter to change coding parameters that can maximize the use of the channel, and minimize the received error rate.

Combined with large-area self-configuring networks, emerging multiplexing technologies are hoped to offer significant gains in bandwidth efficiency — a national resource that is in ever-increasing demand. BE

Aldo Cugnini is a consultant in the digital television industry.

Send questions and comments to: aldo.cugnini@penton.com



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MXF and AAF

Which wrapper you use depends whether you're broadcasting or editing.

BY BRAD GILMER

Many broadcasters know about MXF, and they have heard of things such as MXF for Finished Programs (AS-03) and MXF for Commercials (AS-12). But, this month, I want to focus on MXF's bigger brother, AAF.

In the middle 1990s, a joint task force was created by the SMPTE and EBU. The purpose was to address the impending flood of digital video proposals. There were a number of different, competing proposals on the table regarding compression, handling of metadata and the exchange of program material as files. Many in the industry were concerned that without a concerted effort, the market would fracture, leaving end users to sort it out. Fortunately, the task force produced a number of recommendations that later led to standards that have helped drive industry consensus about what constitutes interoperable digital video.

The remit of the task force went beyond coming up with recommendations for interoperable digital video formats, however. The final report included in its name "Harmonized Standards for the Exchange of Program Material as Bitstreams." The group spent a significant amount of time working on something called wrappers. After spirited debate, it was decided that two classes of wrappers should be developed — one for broadcast and one for editing. The group felt that a single wrapper could not accommodate the differing needs of these two application areas. Ultimately, the wrapper for broadcast became MXF, and the wrapper for editing became AAF.

Figure 1. This simple illustration shows that a wrapper can contain video, audio and data essence such as subtitles.

Before we delve fully into AAF, let's talk about wrappers, what they do and why they are important.

Inside the wrapper

When using professional digital video, specifically SDI video, the relationship between video and audio is set in the standard. SMPTE 259M, and later SMPTE 292M, for HD, not only specified how video and audio should be streamed, but they also were specific about where additional information such as subtitles and timecode should be carried. Other standards specify exactly how this additional data should be formatted. For manufacturers and users, the world was relatively simple; a stream arrived and was comprised of interleaved pieces of video and audio, along with some "essence data" such as subtitles.

But, in a file-based world, there were many possible ways to exchange the same program material contained in the SDI stream. Should you send a video file, followed by a separate audio file, followed by a data file that told how to play back the two files in sync? Should you send a single file with everything in the same file? Should the video be kept separate from the audio, or should it be mixed together, as in an SDI stream? Where do you put the all-important timecode? And, how do you relate the timecode to the video and audio to which it refers?

Those were just some of the questions that surfaced when we looked at transporting programs as bit streams. The wrapper gave us a way to describe how the video, audio, subtitles, timecode and other "essence" should be packaged together in order to be sent from one place to another. A wrapper can contain video, audio and data essence (subtitles). (See Figure 1.) The concept of a wrapper as a way to organize essence is common in both MXF and AAF. This is a simplistic drawing, but it gives you the idea that the wrapper contains video, audio and data, along with identifiers that are used to keep track of each essence component.

The reason I say that this drawing is simplistic is that there are further definitions within MXF itself that constrain the possible arrangements of essence within the file. For example, MXF OP-Atom requires that only a single essence component be included in a file. In other words, an MXF OP-Atom file contains only a single video element or a single audio element. MXF OP-1A allows the combining of video and audio in a single wrapper. But, again, how are the essence types laid out in the file?

Some MXF files contain video as a separate entity from audio. Others contain interleaved video and audio, meaning there is a single essence file that contains a bit of video, followed by a bit of audio channel 1, followed by a bit of audio channel 2, and then back to video again. There is also room in the interleaved file for subtitles.

One last important point: MXF and AAF specifically allow someone who receives the file to understand how video, audio and essence data all relate on a timeline. Of course, this is critical to working with professional video.

The need for AAF

If MXF contains many different possible layouts, you may be wondering

why there is a need for AAF at all. The reason is fairly simple. AAF allows you to wrap up many different tracks of video, audio and data essence, and describe how these different tracks relate to each other. Think about layering or compositing in an edit application. For those not familiar with this idea, layering allows an editor to superimpose one layer of video, say an animated graphic or a window of video, on top of another base layer. Compositing is a common application in editing, but it is not common in the on-air environment, where users generally are playing back finished program material.

An AAF file could contain a base layer consisting of a video and two audio tracks, a compositing layer consisting of another video and two audio tracks, plus some editing metadata that instructs how to manipulate these two pieces of video to produce the finished result. (See Figure 2.)

Another difference between AAF and MXF is a result of what I stated above — that MXF is primarily intended to be used in an on-air environment, while AAF is generally intended to be used for editing. Therefore, it is a common user requirement that MXF files be complete and ready to play at any time. Therefore, many (but not all) MXF files contain video and audio *inside* the file. By contrast, it is not uncommon to find that an AAF file that contains only

Figure 2. An AAF file could contain a base layer, a compositing layer and some editing metadata.

references to external essence. In other words, the AAF file is small and only contains metadata, including pointers to the actual essence files and other metadata with instructions regarding what to do with them.

So, why is there this fundamental difference between AAF files and MXF files? Well, imagine you are in an air playout situation. The last thing you want to find out just as you are going to air (or after you have pressed the "play" button) is that an audio or video track cannot be located on a remote storage device. Since MXF files need to play when the "play" button is pressed, it makes a lot of sense to package video and audio inside a file.

By contrast, think about a typical broadcast promo. If your station produces local promos, you might be surprised to find out how many separate video, audio, graphics, subtitle and descriptive video elements go into a simple 15-second promo. Now, imagine a half-hour, multi-camera, pre-produced news program. This edit project could have more than 1000 (several thousand, actually) individual elements associated with it. It is likely to be more efficient to organize separately the different elements going into this program on disk, perhaps using shared storage. An AAF file could then be a lightweight, metadata-only file, with pointers to the actual content stored on shared storage. This is a common way to build a professional video editor.

So, AAF and MXF may be used differently, depending on the application. For finished programming, use MXF. For an edit environment, or an environment where you need to describe the relationship between a number of separate elements, use AAF.

Lastly, AAF and MXF are interchange formats and meant to be the lowest-common-denominator to get content from one system to another. It is common or likely that inside a system, you will not find AAF or MXF (with some exceptions). Also, since these are baseline formats, it is common to find capability-adding extensions. But, these extensions could hamper interoperability. BE

Brad Gilmer is president of Gilmer & Associates, a consulting technology firm. He is also executive director of the Advanced Media Workflow Association and executive director of the Video Services Forum.

? Send questions and comments to: brad.gilmer@penton.com


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Wireless microphone systems

Preparation is the key to avoiding audio problems.

BY DEE ANA BELL

Recently, a colleague of mine traveled to Seattle to do a field production. He and his assistant spent the morning testing their gear, including the wireless microphone system mounted on the back of the camcorder, while setting up their shot. The wireless microphone setup provided for dual mics, but only one lavaliere was needed for this assignment. Everything worked fine prior to the shoot, but when the talent arrived and was miked up, swishing sounds were present in the microphone audio. Because the videographer did not have the time to troubleshoot the new system, he simply finished the shoot with a standard wired microphone.

One of these things is not like the other. Wireless microphone systems have their own set of potential problems, but with adequate preparation and some troubleshooting, they can be overcome.

By definition, a wireless microphone system is simply the replacement for the audio cable connecting the microphone to the sound system. It is a microphone with an attached or built-in radio transmitter that sends to a nearby receiver tuned to the same frequency. The receiver's output is connected to the camera or studio sound system. This configuration eliminates the microphone cable, giving the talent freedom of movement and location.

Unfortunately, achieving this result is sometimes not so simple because of external radio interference and the difficulties sometimes caused by close channel spacing. To overcome these issues, engineers and shooters need to be prepared to address a variety of obstacles, some of which can be tough to eliminate.

Wireless does not mean interference-free

Stating the obvious, wireless is definitely not an economical replacement and not as simple as the audio cable, yet it has become a preferred method for many professionals in the field. A wide variety of wireless microphone systems are available, ranging from analog, to digital hybrid to all-digital systems, the newest wave in wireless microphone systems. Wireless microphones can operate in VHF, UHF, 2.4GHz and even 6GHz to 8GHz bands, though most professional wireless microphone systems still stay within the UHF bandwidths because they offer the largest contiguous block of radio spectrum.

In a typical analog wireless system, the transmitter modulates the audio signal with the tuned radio frequency using wideband FM modulation while the receiver demodulates the received radio signal back to the audio signal. If you think about it, the scheme is reasonably close to the same process used for FM radio transmission. The problem is achieving 100dB dynamic range, which is considered the minimum for high-quality audio, and staying within the 200kHz bandwidth limitation.

An unprocessed audio signal transmitted using FM and keeping within the legal bandwidth has a dynamic range of about 50dB. This is because the dynamic range is directly proportional to the amount of FM that can be applied to the carrier. To increase the dynamic range, analog wireless microphones use a process called companding, a combination of compressing and expanding. Compression is achieved by using a variable gain amplifier (VGA) or at the transmitter. This circuit compresses 100dB input range by a ratio of 2:1 to fit within the 50dB dynamic range. Expansion occurs at the receiver, again using VGAs to restore the original 100dB dynamic range. Further signal-to-noise improvements can be obtained by pre-emphasizing the audio at the transmitter input and then de-emphasizing it (reversing the process) at the receiver.

The audio also must be limited to prevent over-modulation and distortion. These processes improve the audio quality but at some cost of high-frequency roll off; it is necessary to roll off lower frequencies that would interfere with the companding circuitry. Therefore, frequency response is

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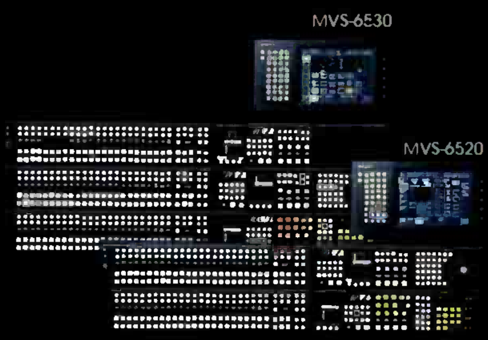

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typically about 50Hz to 15,000Hz for analog wireless systems. Professional analog wireless systems are able to achieve a better frequency response, perhaps out to 18,000Hz, by using more sophisticated circuitry in the companding and pre-emphasis stages.

Digital hybrid systems use analog FM transmission combined with DSP to enhance the system's audio. It replaces the traditional analog companding circuits in the transmitter and the receiver. Using DSP achieves a flatter frequency response through the use of digital techniques such as predictive algorithms. It also can increase the dynamic range and decrease companding artifacts (distortions).

An all-digital system digitizes the input signal in the transmitter, and it stays in the digital format until the receiver output. With the typical digital wireless systems, an analog-to-digital (A/D) converter is at the input of the transmitter, next is the DSP with three main processes, where the digital signal is digitally encoded in the codec channel coding in the channel coder (error correction and synchronization), and finally the modulated signal constructed in the digital modulator.

In the receiver, like the transmitter, three main processes are then performed in the DSP. First, digital demodulation takes place in the digital demodulator, followed by channel decoding in the channel decoder, and then digital decoding in the codec. Finally, if not connected to a digital audio system, it goes through a digital-to-analog (D/A) converter to the analog audio output of the receiver.

Instead of compressing the audio signal, most wireless digital systems use a data compression scheme using an algorithm called a codec (code-decode) similar to MP3. For digital wireless systems, they are specialized codecs like the APT-X lossless codec that have low latency and can operate in a special hybrid mode for applications in communication that are subject to bandwidth constraints. The result of the high-performance lossless compression is after decoding the compressed data stream; the original uncompressed audio is restored in high quality.

The advantages of digital wireless systems include wider audio bandwidth, no intermodulation distortion and the availability of more operating frequencies via closer spacing.

Digital wireless technology keeps advancing, and manufacturers will soon release digital wireless systems with no digital data compression in the UHF bandwidth. By not having compression, a digital wireless link may provide the ability to match the sound quality of the wired microphone.

Some limitations

One of the disadvantages of wireless

microphone systems is the potential for interference. There are three basic types of interference: radio frequency interference (RFI), intermodulation (IM) and electrical interference.

In the example earilier, the videographer's system used diversity technology, which means each receiver has dual antennas. A diversity system helps reduce multipath caused by RF reflections, which cause fluctuations in received signal strength and fading. Nondiversity receivers have only one antenna. Intermodulation arises from the combination of two or more signals at different frequencies within nonlinear circuits and can occur when transmitters are operated close to receivers or other transmitters. IM does not occur in digital modulation, which is one of the advantages of digital wireless systems.

Today, nearly all wireless systems provide frequency agility instead of the single-frequency-crystal-tuned systems of the past. Typically, wireless systems are tunable across a specific band of frequencies. Manufacturers even offer software for frequency coordinating to aid in finding available frequencies based on your location. Frequency scanning can also be helpful in finding a clear, available frequency.

The shooter in my story did have a frequency scanning options, but he was not sufficiently familiar with the feature to quickly identify and resolve the noise problem. It was, therefore, quicker to fall back to older, but reliable, wired microphone technology to complete the shot.

High-end systems

There are some sophisticated wireless systems available. Intelligent wireless systems use 2.4GHz back channels to communicate with the transmitter and the receiver in a two-way data link. This permits the user to actually change operating frequencies on the fly. With remote control, the user is able to change audio gain, transmitter power and even transmit frequency on some systems. In addition, some wireless systems' receivers can recognize an interfering signal on the audio link and tune both receiver and transmitter to a clear channel with little signal interruption.

Of course, the price and complexity of convenience increases with each feature (even more so if its digital), and such systems are not needed for most live camera stand-ups. I am still waiting for the day when wireless microphone systems can reliably match wired microphone performance at a wired microphone price. BE

Dee Ana Bell is chief operator/production engineer for NWPTV and NWPR at Washington State University.

Cloud storage

High-speed, secure networks are needed to realize the benefits of the cloud.

BY PATRICK SCULLY

Despite some concerns over the cloud's ability to serve as a reliable and cost-effective storage solution for business and consumer applications, we are seeing a shift toward it. The equipment and services markets are growing rapidly for cloud storage services. For example, the Taneja Group estimated the total cloud storage hardware market in 2010 was $3.2 billion, growing 31 percent per year to $9.4 billion by 2014. And 451 Research calculated the cloud storage services market was $769 million in 2010, growing 47 percent per year to $4.4 billion by 2014.

The rationale for such growth curves is certainly worth exploring. A study from Forrester points to a significant cost advantage of cloud storage solutions over traditional internal enterprise storage. In that study, the annual cost of cloud storage for 100Tb of data was estimated to be $231,600 vs. $955,500 for internal storage, a 76 percent reduction in storage costs.

Some media and entertainment applications could benefit from the lower-cost cloud storage model because the creation, distribution and conversion of video content in digital form is a huge driver of storage and corresponding data protection.

Media and entertainment is seeing an unprecedented growth in storage due to higher-frames-per-second (fps) cameras and video resolution. For example, fps has increased from a historical 24fps to 48fps in the upcoming film *The Hobbit* by Peter Jackson, to 60fps in the latest *Avatar* movie, with increases to 300fps expected in the near future. At the same time, digital video production continues to increase resolution from 2K initially to 4K today, with 8K and 16K distinct possibilities for the future.

As a result, the raw video content produced by high-resolution digital production can quickly get into the Tb/h — even more for stereoscopic capture from multiple cameras. For example, Coughlin Associates predicted a more than fivefold increase in entertainment-industry storage between 2012 and 2017, and will reach more than 87 petabytes (Pb) of storage shipped per year. Even when only considering cloud services for vaulting capacity to complement internal data centers, this represents a significant cost-savings alternative.

Data protection

Data protection and archiving measures are more complicated because of this massive video data generation. Data protection typically involves making copies of the original data, and ensuring copies are distributed, both across multiple disk arrays and geographically. This ensures the survivability of the vaulted content and its availability whenever it is required. Typically, nonlinear editing (NLE) post-production storage is a mix of direct and network-attached local storage. Coughlin Associates recently found that 15 percent of participants are now using cloud-based storage in their post-production, and around a quarter of these had more than 1Tb in the cloud.

Recent service outages from cloud providers, such as Amazon EC2, Google and Microsoft, only reinforce the point that even well-tested backup plans can occasionally fail and cause downtime. Although these are becoming less frequent as the cloud model matures, the basic data protection practice of multiple data sets in multiple locations should still be deployed for maximum reliability. Failing to follow these principles can lead to major production delays when the cloud is used in a collaborative workflow and negatively impact the sale and distribution of content to downstream users.

As they move to file-based post-production, broadcasters are putting more of their content in the cloud.

Although the cloud services discussed until now are applicable across various industries, from media and content production to financial and government-use cases, let's now explore different use cases of the cloud for the media and content production and distribution industry and their networking implications. Focusing on cloud storage, let's consider three typical use cases: backup/archive, content and I/O. Among the three, each is defined by different parameters, such as I/O specifications, including bandwidth and response time; geographical diversity; annual downtime; and recovery point and recovery time objectives (RPO and RTO).

In the case of backup or archive storage, one can consider how such

an approach can help the industry meet vaulting requirements of raw and/or produced content. Given the enormous amount of storage required for applications such as sporting events footage or the next blockbuster hit (tens or hundreds of petabytes of data), the cost savings of cloud storage are extremely attractive. In this case, characteristics such as geographical diversification and recovery consistency and assurance would typically have more influence in the service definition than the bandwidth and response time.

Content storage, on the other hand, could be characterized by higher availability and I/O rates. It also benefits from a certain degree of geographical diversification for storing and distributing large files. Distribution of produced content, such as television programming, movies, trailers and clips to various partners, thus, becomes simplified and more cost-effective. Higher availability here ensures content can be sold and distributed when needed, and in a timely manner with sufficient bandwidth.

A third use case for cloud storage would be better served by I/O storage. Optimized for performance with greater bandwidth, reduced response time and highest availability specifications, with less emphasis on geographical diversification, this type of cloud is primarily geared toward active development. This would be ideally suited to content ingestion and post-production workflow collaboration. When we consider the size of individual video frames (roughly 50MB for 4k frames), this translates into high bandwidth requirements, whether we consider real-time content ingestion (from 1.5Gb/s to more than 12Gb/s for current formats) or faster-than-real-time transfer of stored content using 40Gb/s or 100Gb/s transmission rates. The low-latency characteristic of this type of storage also makes it suitable for online post-production work.

Although the compute offering of the cloud creates an interesting alternate and/or complementary solution for the media and content industry, such as transcoding and watermarking, it relies on the same type of networking infrastructure used for other parts of the cloud offering.

Network architecture

For this potential to be fully realized, however, the various types of cloud services described in the preceding paragraphs can deliver only the performance the underlying network architecture will allow. The foundation of this architecture starts with a high-speed, high-capacity network that can withstand the enormous amount of data being uploaded, edited and retrieved from the cloud. Whereas 2.5Gb/s or 10Gb/s speeds were deemed plentiful less than a decade ago, today's applications benefit from 40Gb/s and 100Gb/s coherent networks.

The traffic flows must also be optimized to ensure latency-sensitive applications are prioritized and routed accordingly through a service-aware architecture. For example, the speed and reliability of the network is of utmost importance for news editors and producers who must edit hours of raw footage into a 30-second spot for the next newscast. In this case, not only does the cloud need to be available and reachable, it needs to be accompanied by a highly resilient network infrastructure offering five or six "9s" of reliability (99.999 percent or 99.9999 percent uptime) as part of the overall network design for business-critical applications using available protection, mesh and control plane options.

In addition to high resiliency demands, today's networking infrastructure must be able to respond to predictable, and unpredictable, bursts of traffic appropriately

Even well-tested backup plans can occasionally fail and cause downtime.

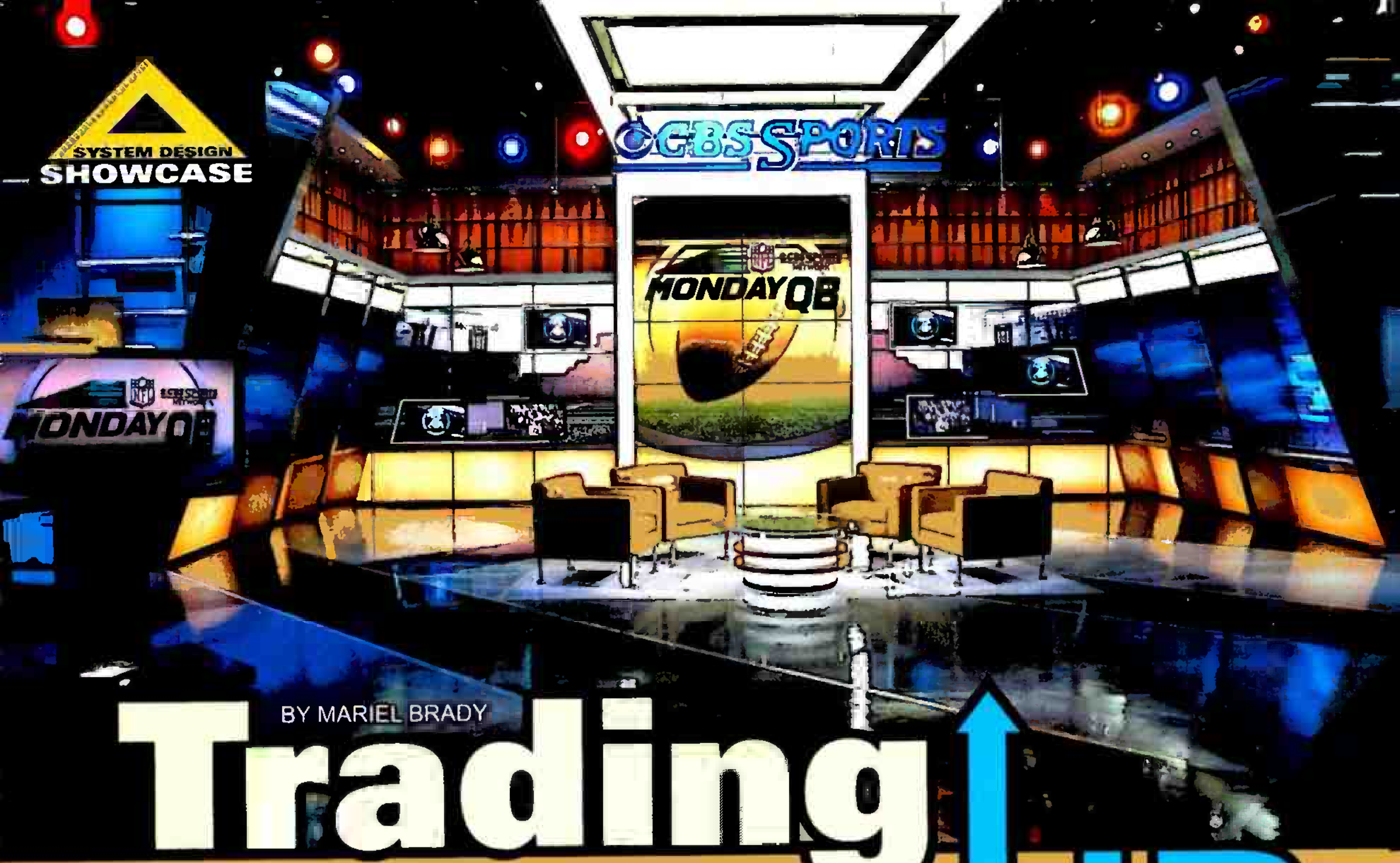
with scalable bandwidth. If not, video editors, news producers and content distributors will incur serious headaches. In addition to varying bandwidth demands, the architecture must also be flexible to accommodate various types of traffic services — whether Ethernet-based, Fibre Channel — or be able to transport video streams in their raw formats.

Given the high value of the content created and distributed in the entertainment and broadcast industry, and the inherent data protection requirements, it is also important to consider the security aspect when dealing with cloud services. Even though content is viewed as generally secure once in the cloud, (a recent survey from 451 Research found that only 10 percent of respondents considered the data in the public cloud insecure), an important aspect of protecting the proprietary information is considering the security of the in-flight content as it transits to and from the cloud. A networking solution that incorporates data encryption as part of its transport infrastructure alleviates that concern by ensuring the data is kept secure as it traverses the network and complements the cloud offering by securing the data while in transit.

Such features and characteristics of an assured network help accelerate and facilitate access to cloud solutions for a number of use cases in the broadcast industry and, along with the significant cost advantages of the cloud compared to internal data centers, are key considerations when evaluating networking options. A powerful, carrier-class production network with enhanced security provisions, along with cloud-based services, is guaranteed to assist the video production industry in overcoming the quality, latency and security challenges of today's increasingly distributed file-based workflows. **BE**

Patrick Scully is product line manager and video transport expert for Ciena.

SYSTEM DESIGN SHOWCASE



BY MARIEL BRADY

Trading UP

CBS Sports Network's studio upgrade has a major player at the top of its game.

CBS Sports Network, the cable home of CBS Sports, had outgrown its studio. Built in 2003 for CSTV: College Sports Television, a cable start-up featuring college sports, CBS Sports Network's Chelsea Piers studio in New York City was in need of an update.

The upgrade began in 2010 with the network's transition from standard- to high-definition. It continued this summer with the goal of revitalizing and upgrading the network's on-camera look with a new set, as well as expanded graphics and transmission areas to accommodate the growing network's needs.

When setting out to design and build a new studio, network executives had to take into account not only the dozens of studio shows and original programs produced out of the facility, but the more than 350 live games produced by the network each year.

Project planning

Patty Power, senior vice president of operations, and Kelly Dunne, senior vice president of marketing and creative services, led the group in designing the new set, along with a design team from Jack Morton Worldwide. The group wanted to make better use of the 6,000sq-ft stage occupied at CBS Sports Network, only half of which was utilized by the old set. Another goal was to raise the grid, which had been rather low despite the studio's 20ft ceilings. Having more technology visible throughout the set was a priority, as the team sought a more modern look.

Power and Dunne also worked with chief technical officer Walter Raps and Tyler Hale, vice president, studio production, to identify an operations and production workflow — one that allowed the creation of a state-of-the-art, cost-effective facility that could be completed in a tight time frame. While planning for the process began over a year prior, actual

The new CBS Sports Network studio was designed to make better use of 6000sq-ft of space, where the old set used only half of that.

Technology at work

ASG Atempo: archival software
Belden: 1505A, 1694A and 1805A cabling
Blackmagic Design: routers
Calrec: Omega digital audio console
Cobalt Digital: 9084 RGB color corrector
Data Direct Network: storage with 300TB for hi-res and 120TB for proxies
Dataton: WATCHOUT multi-display production and playback system
Evertz: 3000DVT video wall processors
EVS: XT2 servers
Impulse Design: custom furniture
Miranda: Kaleido-X multiviewers, NV8576 hybrid router
NEC: 32in and 46in monitors
Orad: PlayMaker HD/SD slow-motion server
Panasonic: 85in display
Primestream: FORK production suite
Sharp: 60in monitor
Sony: HSC300K multiformat cameras, MVS8000X production switcher and XDCAM PDW-HD1500 recorders
SpectraLogic: T120 robot library
Talley Display: LED screen

renovation could not begin until after the NCAA Division I Men's Basketball Championship in April. It then needed to be completed before college football season in August.

Technical facilities

After the design and technical requirements were clear, Richard Hart, vice president, entertainment production and technical operation, CBS, ensured that construction and installation were implemented by the CBS Scenery Shop. This group has been involved in all major productions constructed at CBS for more than 50 years. Most recently, it has been involved with the fabrication of "CBS This Morning," WCBS local news, "Anderson Live," CBS Sports and "CBS Evening News." Projects are fabricated through the direction of shop head David Tasso and his team, including shop foreman Tom Bianco and project engineer Pat O'Donnell. Head electrician Joseph Bradley and charge scenic artist Mark Prouse created the intricate lighting, paint and graphics.

Project engineer Patrick O'Donnell took on implementing the design and working closely with Marianne Fischer and Raps to construct the production space. Fabricating the unique set that boasts layers of monitors, metallic details, custom LED light fixtures, oversized ceiling units and an immense anchor desk was challenging. After the fabrication process was completed in their facility, Bianco then oversaw the installation.

Nearly 50 new LCD monitors, including a mix of 32in, 46in, 60in and 85in displays, help the CBS Sports Network staff produce shows and more than 350 live games each year.

Raps and his team oversaw the installation of nearly 50 LCD monitors — a mix of 60in Sharp, 46in NEC, 32in NEC and 85in Panasonic displays, all fed from three Evertz 3000 DVT video wall processors. The system was configured with 18 shared inputs and 54 outputs, as well as a Dataton WATCHOUT multi-display production and playback system with eight outputs. An LED screen from Tally Display, similar to those used at stadiums, also was installed in the set's floor, allowing the creative team to simulate fields and courts. Both the videowall and floor screens can be fed from any video source on the facilities' Miranda hybrid router or Sony MVS8000X video switcher, which pass through Cobalt's 9084 RGB color corrector for final adjustments.

Updates also included a SAN upgrade, which increased proxy storage by about 58 percent and main storage used for high-res video by about 55 percent. The Data Direct Network is about 300TB for high-res and 120TB for proxies. Archival software uses ASG's Atempo with some custom written modules, utilizing the network's existing SpectraLogic T120 robot. Transmission was moved to a larger space, allowing for future growth. IP connection was enhanced between the Chelsea Piers facilities and CBS television network broadcast center about 2.5mi away, which will allow additional feeds to and from the center. In all, the team re-wired more than 10mi of studio wiring, including Belden 1505A, 1694A and 1805A cabling.

In addition to transmission, all studio and remote graphics operations were relocated to a larger, self-contained location with room for growth and enhanced quality control. Blackmagic Design routers were added to existing Miranda multiviewer feeds to user monitors so they can be easily switched out depending on show requirements. Custom furniture from Impulse Design was also added, as was further integration with CBS Information Technology and CBS Interactive for score and statistics feeds.

Studio C and Control Room C, where the "Tim Brando Show" is produced daily, were relocated to allow for the larger main set. Also, audio and video ties were increased, and the integration with the main control rooms also was enhanced.

Other upgrades included five Sony HSC300K multiformat camera systems, hardware upgrades for the two EVS XT2 systems, several Kaleido-X multiviewers and the Miranda NV8576 hybrid router.

The control room features a Sony MVS8000X with 80 inputs, four ME and four DME channels, as well as a Calrec Omega 56 fader 5.1 capable digital audio console. Production capabilities include a 2x Orad PlayMaker, 2x EVS XT2, 12 Sony XDCAM PDW-HD1500 recorders and 24 channels of live XDCAM format ingests using Primestream's FORK production suite. BE

Mariel Brady is junior publicist, CBS Sports Network.

Project team:

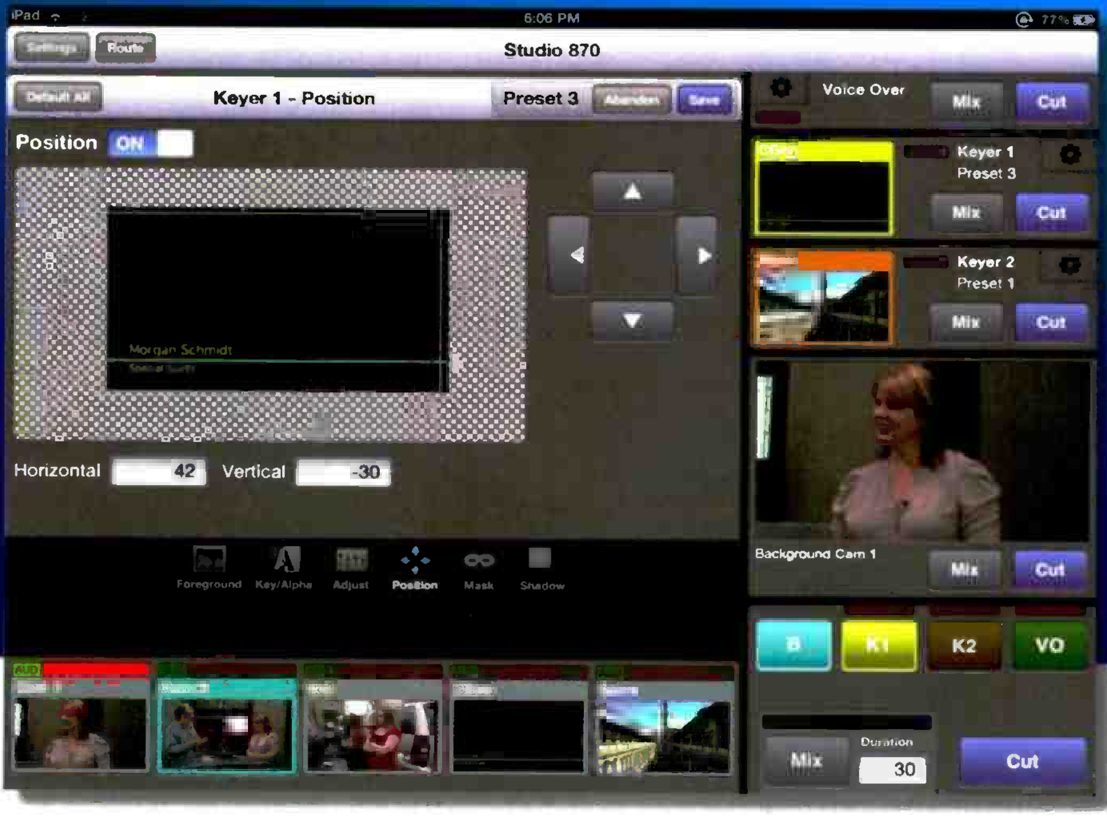
CBS Sports Network: Patty Power, senior vice president, operations; Kelly Dunne, senior vice president, CBS Sports marketing; Tyler Hale, vice president, studio production; Walter Raps, chief technical officer; Marianne Fischer, vice president, studio operations; Demetra Marcus, vice president, marketing

CBS Scenic Shop: Richard Hart, vice president, entertainment production and technical operation; David Tasso, shop head; Tom Bianco, shop foreman; Pat O'Donnell, project engineer; Joseph Bradley, head electrician; Mark Prouse, head scenic artist

Installation Technicians: Jim Parkinson, timeframe productions, system engineering & integration; Mike Steinhart, director, broadcast technology solutions; Jonathan Handler, broadcast post production engineer; Thomas O. Carroll, Jr., installation technician; Mike Moutopoulos, installation technician; Ryan Breen, installation technician; Doug Terpsa, installation assistant

Jack Morton Worldwide: Juliann Elliott, associate designer; Andri Durette, senior design director

New Keying and Layering Technology



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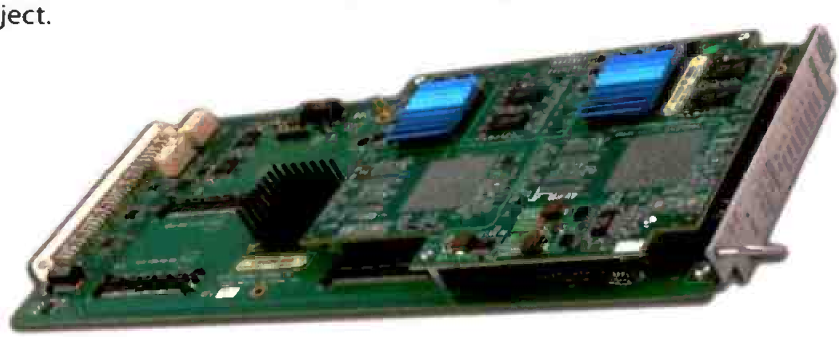

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Shooting Quad HD for HD projects

Figure 1. Camera view with the 10X lens zoomed-in

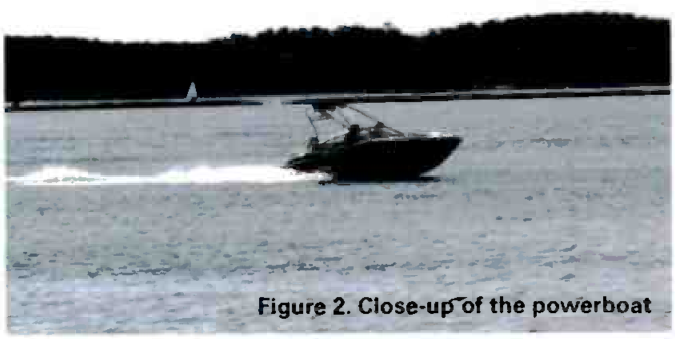

Figure 2. Close-up of the powerboat

Figure 3. Close-up of skiers

The increased resolution enables full HD crops.

BY STEVE MULLEN

Were I to suggest that there are advantages to shooting certain broadcast projects with a 4K2K camcorder, I have no doubt what your response would be after giving me a harsh "are you crazy" look: "There's no editing equipment for 4K2K, no distribution system of any kind and no 4K2K HDTVs for sale at any price."

Telling you that several 4K2K HDTVs have already been announced for delivery during the remainder of this year will not, I am sure, modify your negative view. Nor will telling you that I can edit 4K2K on a lightweight MacBook Air be likely to modify your opinion.

The fact that neither in-plant nor external distribution systems can handle 4K2K is a solid reason in your view that super HDTV is years, if not a decade, away.

Nevertheless, I've little doubt that when you shoot digital photographs, whether you display them on your computer monitor or HDTV, you shoot your photos with a camera that has 12 to 16 megapixels. In fact, if you have one of the newest cameras,

Figure 4. Wide shot from a locked-down camcorder

Figure 5. View of the dock, jet ski, lake and sky

Figure 6. Close-up of the jet ski

you may be shooting photos with 24 to 36 megapixels.

There are two reasons why you shoot photographs with six to 18 times more pixels than can be displayed. First, the higher the shooting resolution, the better image detail that will appear on a lower-resolution display. Second, the high-resolution original allows you to severely crop a picture and still have more than 2 megapixels in the cropped image.

Both of these reasons also apply to shooting video. The key is to think of source resolution separately from distribution and viewing resolution. One can shoot at four times the distribution and monitor resolution. Second, the ability to crop video is important when shooting sports or documentaries.

In this article, we'll look at four different types of cropping that can be applied to video. I used JVC's GY-HMQ10 Quad HD handheld ENG-style camcorder.

Multiple view crops

When shooting with a single camera, one lacks the ability to capture multiple views of the same subject. However, if one has a super-resolution source image, one can crop multiple views from the same video. (See Figure 1 on page 40.)

Let's look at a close-up of the powerboat pulling two skiers. (See Figure 2 on page 40.) It's important to remember that even though this is a crop, it still has 2 million pixels that comprise a full HD image.

Similarly, a close-up of the skiers still contains 2 million pixels. (See Figure 3 on page 40.)

Because both views come from the same camera as it pans with the action, it's possible to cut between the views. It's also possible to superimpose the two views.

Crops from locked-down camera

In some cases, it's desirable to place a camera on a tripod and lock it down for a wide shot. The problem, of course, is that a wide view is only useful in a few situations. It often functions only for establishing shots and brief cutaways. (See Figure 4.)

In a much better composed shot, most of the distracting objects have been cropped away, leaving a view of the dock, jet ski, lake and sky. (See Figure 5.)

Having the ability to pull multiple shots from a locked-down camera gives the producer the ability to make more use of the camera. (See Figure 6.)

As we will see, an NLE's ability to crop, over time, from one view to the other enables the locked-down shot to look like a camera zoom — something that could only be accomplished were a remote-controlled pan-tilt head and remote zoom control available to the camera operator.

Pan and zoom crop

Final Cut Pro X provides a "Ken Burns" effect that can be used to animate cropping within a Quad HD image. The green window defines the initial view, while the red window defines the final view. (See Figures 7, 8 and 9 on page 44.)

Figure 7. Green window defines initial view, while red window defines the final view

Figure 8. Beginning of pan and zoom

Figure 9. Final frame of pan and zoom

Note that the rightward digital pan is possible even though the camera is panning to the left. If this pan looks disturbing, one can place a smaller green window over the kids while placing a larger red window over the Jet Ski. In this case, both pans will have the same direction.

Creative crops

Figure 10 shows a wide shot taken by the camera operator. Knowing that the shot should finish with a close-up of the green plants, the operator zooms into the center of the plants.

To the producer's eye, the plant's center is void, containing nothing of interest. (See Figure 11.)

By setting up a digital pan that begins with the whole image and finishes cropped to the right, the final close-up is far more interesting to the viewer. (See Figure 12.)

Export HD

When a crop is larger than 1920 x 1080 (or 1280 x 720), the cropped image is auto-downscaled during export. Of course, it's important not to crop Quad HD to smaller than the export resolution.

Using Apple's Final Cut Pro X, one edits Quad HD exactly the same as one would edit full HD. In both cases, one edits ProRes Proxy copies of the original ProRes 422 HQ or ProRes 422 video.

An export is made to a full HD file using ProRes 422 HQ or ProRes 422 at 1080i59.94 (or 720p59.94).

It's also possible to edit Quad HD using Final Cut Pro and Media Composer (OS X and Windows). Ultimately, the exported file can be sent to a plant's on-air server.

The advantages of shooting Quad HD are available whether one shoots with a low-cost ENG-style camera or a far more expensive cinema-style camera. The difference is one of image quality, not post production. BE

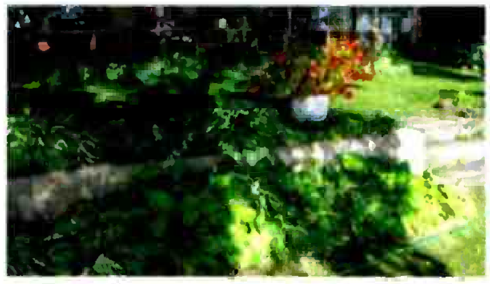

Figure 10. Wide shot of garden

Figure 11. Zoom into center of the plants

Figure 12. Corrected zoomed view

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CELLULAR BONDED VIDEO

Live transmission from events like the NFL Super Bowl is among recent uses for cellular bonded technology.

Sports are covered in new ways with the technology.

BY KEN ZAMKOW AND MEIR SCHRIEBER

Cellular-based bonded uplink is becoming a frequent sight in sports venues. By using portable devices that bond together multiple 3G, 4G and other data connections, broadcasters can now quickly transmit live video from anywhere at lower costs than traditional uplink solutions, as well as transmit on the move or inside structures without line-of-sight or cabling restrictions. This has led to a variety of applications, such as transmitting a much greater number of live varsity games, sports news hits from the road, complete live press conferences and previously impossible live footage from inside locker rooms, golf courses, race tracks and more.

However, while allowing greater flexibility and lower costs, it is also important to understand limitations of transmitting over public cellular networks, and to use the technology in ways that produce the best results.

How it works

Bonded cellular video technology is an aggregation technique designed to group several physical links into one logical link. This provides fault-tolerance and high-speed links between the aggregation device and its paired bonding server.

The technology enables the use of several links (from two to 32) and combines them to create increased bandwidth and the data/video trunk. Should links fail, the bonding technology automatically redistributes traffic across remaining links. Automatic redistribution is done in typically less than 100ms, so no outage is noticed. In practice, a number of separate cellular or other data connections — which, individually, may not be very robust — are combined into a bigger pipe. This pipe can transmit despite any temporary individual lost connections to the cell tower or lost packets on the way to the server, for example. Data connections can include 3G and 4G modems across most major U.S. cellular carriers, as well as Wi-Fi, WiMAX, Ethernet and even portable satellite links.

The bonding device encodes video coming from a camera or a field switcher, dices it into multiple data packets and transmits each group of packets through a different modem or carrier. Information travels through cellular towers and the public Internet, and arrives in a receiver that recombines data into raw video again and then outputs it to a studio switcher (for on-air) or transcodes and sends it to a content delivery network (for online).

Typical bit rates

Transmission rates can vary dramatically based on location, time of day and number of people in a certain area. In good 4G areas, transmission rates may be as high as 10Mb/s to 12Mb/s, compared to an average of 1Mb/s to 3Mb/s in some 3G areas. Of course, it's impossible to predict available bandwidth at a govem to,e. Therefore, another job of the bonding solution is to characterize each link every few milliseconds in terms of bandwidth, delay and loss rate. Then, it creates a Gaussian normal distribution graph for each parameter, assigns a real-time weight based on the graphs, and feeds this weight to the scheduling/queuing process. This allows for the best real-time decision regarding which link the next incoming packet should use. Typical bonding techniques use the following methods to overcome fluctuations:

- *Adaptive bit rate*: By changing the encoding rate on the fly, the bonding unit can maintain transmission even as bandwidth swings.
- *Signal boost*: The bonding unit may use special antennas that increase range compared to consumer air cards, as well as overcome multi-path fading in environments where signals bounce around different obstacles (walls, beams, etc.).
- *Forward error correction (FEC)*: The unit will send redundant data along with the main feed, so that if some of the original packets are lost, the decoder can still recover the information. The Reed-Solomon FEC algorithm takes a predefined block of packets (FEC group) and calculates several augmented FEC packets. If, for example, the FEC group is composed of 20 packets, and we add four FEC overhead packets, any lost packet, up to four, can be recovered.

- *Latency control*: The higher the latency is, the more likely all data packets will arrive in time. Users can select a low latency (as low as subsecond end-to-end), which carries a greater risk of occasional packet loss. Or, a higher latency (anywhere from 2 to 60 seconds, or even store-and-forward) can be chosen, which provides more time to recover lost data. End-to-end latency has a great effect on bonded link quality. If a user selects a low end-to-end delay, say one second, then considering encoding and decoding time, and SW processing time (approximately 500ms), the remaining time for a packet left to arrive from the transmitter to the receiver may be as low as 500ms.

It's up to users to decide which parameters to use, based on the content transmitted. On-the-move coverage, where changes are fast and individual link properties vary, a higher end-to-end delay profile will enable better recovery from changes without data loss. But, in areas with good cellular coverage, when the camera is static, a lower delay profile can work fine.

Cellular-based uplink makes live shots from the NBA's All-Star Weekend possible with just a single camera.

- *Changing resolutions*: As resolution increases, the bit rate also needs to increase. By lowering the output resolution, one can get by with lower bandwidth in congested locations. The bandwidth control engine detects any state where the outgoing bandwidth is lower than the encoding bandwidth. It will then decide whether to let the encoder use a higher Quantization Parameter (which lowers the encoder bandwidth), or perform a video scaling (feeding the encoder with a lower-resolution image) in order to lower the encoding bandwidth.

A good bonding engine will receive from the user general preferences (low delay, best quality, etc.). Based on these, it will automatically adjust bonding parameters. This means the engine will decide on a packet-by-packet basis how much FEC overhead to use, the optimal encoding rate, what resolution to use at any given time, what frame rate to use, what packets to drop under extreme low

BW cases, what packet lost recovery mechanism to use (retransmit, FEC, error concealment, bad frame skip), and how to promptly compensate the overall system knobs upon any network behavior changes that affects the uplink capabilities.

Common uses

Some of the most frequent recent uses for sports coverage include:

- *Live ENG*: Channels have utilized cellular bonding to transmit live from road games, press conferences and events like the NFL's Super Bowl, NBA All-Star Weekend, the Olympics and the World Cup. A reporter or photographer can set up a live on-air shot from a single camera and send footage back while covering a team or a competition. All of this is done without trucks or hardwired connections.
- *Upload edited packages*: Reporters can upload edited packages from the road without relying on slow hotel Internet connections or individual mifi cards.
- *Live behind-the-scenes camera*: Broadcasters or franchises can set up exclusive behind-the-scenes web shows while walking around locker rooms, stadium suites, etc. Similarly, rather than only clipping sound bites, many stations' and franchise's websites stream coach and player press conferences for the benefit of devoted fans.
- *Live varsity games and specialty sports*: Thanks to the lower cost of cellular transmission, broadcasters, schools, new media publishers and specialty sports groups can transmit full games and competitions to the web that traditionally would not be shown on-air. Many times, these productions vary from one camera to a fully switched production fed to the bonded unit.
- *In motion, in the field*: Freed from line-of-sight restrictions, cables or trucks, broadcasters are using bonded backpacks to transmit races from onboard moving cars, boats and helicopters without requiring RF solutions.

Summary

Traditional uplink solutions provide guaranteed bandwidth. Yet, these can be costly and require line-of-sight, cabling or fixed locations. Cellular bonded uplink can vary in transmission rates, but it opens a variety of sports live coverage opportunities from new locations and on new platforms by understanding needed parameters. Networks, stations, new media publishers, leagues and teams can optimize the use of cellular bonding and create a breadth of new content offerings that were once too expensive or complex to produce. BE

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Harris' Versio

The channel-in-a-box platform allows broadcasters to adapt and evolve workflows.

BY ANDREW WARMAN

To call channel-in-a-box an industry trend is to state the obvious. But, to say that every solution follows the same design and deployment philosophy is not necessarily accurate.

In many cases, the channel-in-a-box (CIB) explosion helps broadcasters simplify new channel launches and addresses needs like disaster recovery. How these needs are solved varies greatly, even within the boundaries of what we know today as CIB.

Versio combines baseband video, channel branding and automated workflow capabilities in an easy-to-deploy, software-based 1RU platform.

The new Harris Versio integrated playout platform builds in the required functionality to launch a channel while providing freedom to integrate wide-ranging external workflow components. This is a significant advantage for broadcasters that need to leverage content across the workflow, including, but not limited to, existing shared storage systems, traffic and billing, and asset management systems.

For broadcasters concerned with reliability, a key benefit is the ability to gradually transition workflow functions to the platform. The baseline Versio product combines video server, channel branding, graphics and automation components in its 1RU form factor. Automation and/or clip storage doesn't have to be internal, allowing for a smoother transition and a choice of how to manage playout and deal with associated risks.

The overall feature set compresses multiple functions into the design with the ability to scale from one to hundreds of channels. It doesn't force broadcasters to use all capabilities.

Beyond the chassis' own capabilities, the solution also reaches farther across the workflow, allowing users to leverage existing digital asset management and traffic and billing systems. This helps manage overall channel costs and potentially increase revenue by bridging business and playout functions. The tight integration allows traffic operators to sell and schedule new commercial spots in close proximity to air time.

Reason for existence

Cost-efficient operation of multiple channels is often essential to the growth and success of broadcasters. Consumer thirst for new programs, special interest channels and content across multiple viewing platforms means that broadcasters need to offer intriguing and compelling programming to grow audience share and revenue. However, they also need to be budget-conscious, and new channel launches with specialized content can be expensive.

The launch of multiple channels and services within standard broadcast architecture traditionally requires the purchase and integration of single-function products such as servers, automation, master control switchers and graphics systems. Versio's design offers a solution for broadcasters working to control operating costs while adding channels. It also incorporates proven yet evolving Harris technologies that cover key technical elements. In addition, it offers simple scalability as the number of services increase.

Ultimately, the solution is designed to help broadcasters grow and protect revenue through a flexible, cost-effective platform. The ability to add channels individually makes the cost-per-channel linear, versus sizable investment increments common to standard playout systems for each group of new channels. Time-to-air for new channels is also significantly decreased from months to a matter of weeks or days. As a result, the time taken for turning investment into revenue generation is significantly reduced.

As broadcaster needs change over time, Versio can adapt to those changes with a simple reconfiguration. This may be changing between onboard and external automation, between using shared or internal storage, or by applying software license keys to turn on features.

Features and operation

The shift from hardware- to more software-centric workflow models has already simplified the playout infrastructure. This system evolves the model, offering a single platform to support everyday operations such as file ingest, closed caption and pre-recorded audio insertion, audio channel management, DVE and mix effects, and upstream/downstream device control.

On a more expansive level, the solution allows broadcasters to decide how and when to grow services — including mixed SD and HD content, as well as 2D and 3-D graphic branding. The solution uses its resources, matching appropriate IT hardware with software requirements. Graphic branding is a GPU-centric operation, with its own set of SSD media drives to enable fast loading of graphics.

Harris branding technology also supports optional DVE capabilities and mix effects, as well as RSS and ODBC-driven text such as snipes and lower-thirds. A separate set of hard drives is used for on-board clip storage to maximize storage capacity from the small footprint. CPU supports video encode and decode operations, and allows maximum clip codec and wrapper format support.

The option to use external SAN storage or the platform's standard integrated storage adds flexibility to media sharing. SAN-connected servers stream directly without having to cache content to a local disk via fully redundant Ethernet connectivity.

The integrated video server function supports 2X internal channels, which enable mix effects under automation control and an optional baseband record channel. The output is a fully branded channel, with support for SNMP monitoring, the Magellan log server and Versio's onboard multiviewer. Broadcasters can also run automation directly on the chassis, or leverage a new or existing external ADC or D-Series automation controlled over Ethernet. Used with an external automation system, the platform offers the ability to control more upstream and downstream devices.

The on-board automation function offers full control of integrated resources plus external device control including VTR, router, subtitler and external graphic branding systems. An intuitive user interface allows the operator to monitor and modify playlists independently to centralize control.

The platform's deployment flexibility rests within the integrated software licensing.

The pertinent takeaway is reliability. Deployment options, including seamless integration with existing infrastructure, ensure long-term durability and scalability — with the freedom to control built-in functions as desired. Therefore, broadcasters seeking to prove the reliability of the CIB concept have more freedom to do so.

Beyond the basics

The flexibility of deployments rests within the integrated software licensing, which can quickly enable or disable options. Additional options include advanced branding, including 2X 2D DVE and switching between a live input and disk-based clip playout. Its expansive codec support also reduces concerns for successful clip playback in a wide variety of formats.

Other options reach farther into the workflow, including automated file movement using Invenio Motion media asset management and Harris Live-Update-based interfacing with its traffic and billing systems. The latter employs BXF, which allows fluid playlist changes between traffic and automation functions, so traffic can sell ads almost to air time.

It is clear that CIB will grow in importance in the playout space. The prospect of lower costs, easier operation and simpler, faster deployment are important attractions. Blending this with versatility and proven reliability makes channel-in-a-box a potent option to today's standard approaches. BE

Andrew Warman is senior product marketing manager, Harris Broadcast Communications.

Encoding technology

HEVC may be the next compression technology to arrive in consumers' homes.

BY JOHN LUFF

It seems like we have had compression technology forever. We haven't, unless you include the adoption of interlace scanning, the original analog compression system. Digital compression has existed for essentially as long as we have had digitized video (and audio). I distinctly remember attending SMPTE conferences as a much younger person in which a major topic was "bit-rate reduction" technology, another term for what we now call compression. Context is everything, so let's venture back a bit to see why this was so complicated.

Before CCIR 601

Before ITU-R BT.601 (or its original popular name, CCIR 601) there was little agreement on the sampling format for moving images. The research into how to sample and store video was centered in fine research institutes on several continents. Of course, video was what we would today call standard definition, a distinction that was not helpful before NHK showed HDTV to the world in the late '80s. And there was no common agreement on component video as the basis for imaging, nor storage and transmission.

So, sampling grids did not need to be locked to any other notions, and in fact there was no requirement that it be based on rectangular sample grids. Some proposals that were quite popular included samples aligned 45 degrees to the line structure.

Opening the barn door

When researchers looked into how to compress images, the work first had to be done to define some basic parameters, like how many samples per second it took to reasonably represent and transmit quality images. When SMPTE and EBU did the heavy lifting of trying to define a standard (601) for sampling images, it made a huge difference to the advancement of digital imaging.

It led directly to the development of the first practical digital recorder from Sony, which was uncompressed. Picture quality was never approximate; it was a full and exact reproduction of the sampled image. One might

argue that sampling itself threw away valuable content, and some at the time no doubt did. Indeed, for some applications, that was certainly true. However, the adoption of the 601 standard opened the barn door and let research proceed on bit-rate reduction of standardized streams.

DCT-based compression was not invented for 601 sampled images, but quickly work centered on using DCT as the basis for compression. Two international standards were established to harmonize the work on compression worldwide. JPEG (Joint Photographic Experts Group) and MPEG (Moving Pictures Experts Group) created the base standards we use today in due process bodies from which all manufacturers and users would benefit. Other work preceded MPEG and JPEG, including work that created standards adopted widely in Europe but never very successful in North America, for reasons I have never fully understood.

The ETSI (European Telecommunications Standards Institute) compression standards (ETS 300.174) used rates based on integer fractions of European data transmission standards, especially E-1 at 34Mb/s. One-half and one-quarter of the E-1 rate yielded 17MB and 8Mb rates, which the EBU deployed widely on its satellite network in the '90s. But with the rapid advances in MPEG compression, it became clear that MPEG offered higher quality for the same bit rate, and thus better economy for interconnection. Eventually, broadcasters worldwide adopted MPEG-2, most based on the DVB specifications which facilitated interoperability.

Other forces at work

At work at the same time, of course, are other forces that affected how compression products would be designed and deployed. It is important to recognize that while MPEG was always seen to be a one-to-many approach, with the expense of processing put on the single encoder and cheap decoders making the economics viable, the first deployments were exclusively in the backhaul market.

DVDs brought digital compression to consumer products only after several years of successful and increasingly high-quality deployments in the backhaul market. The use by PBS of General Instruments DigiCipher compression systems for network distribution beginning in 1994 is a good example of early deployments that were successful. But a DigiCipher encoder was expensive, and cost was a major barrier to widespread use of compression, for instance, in satellite newsgathering.

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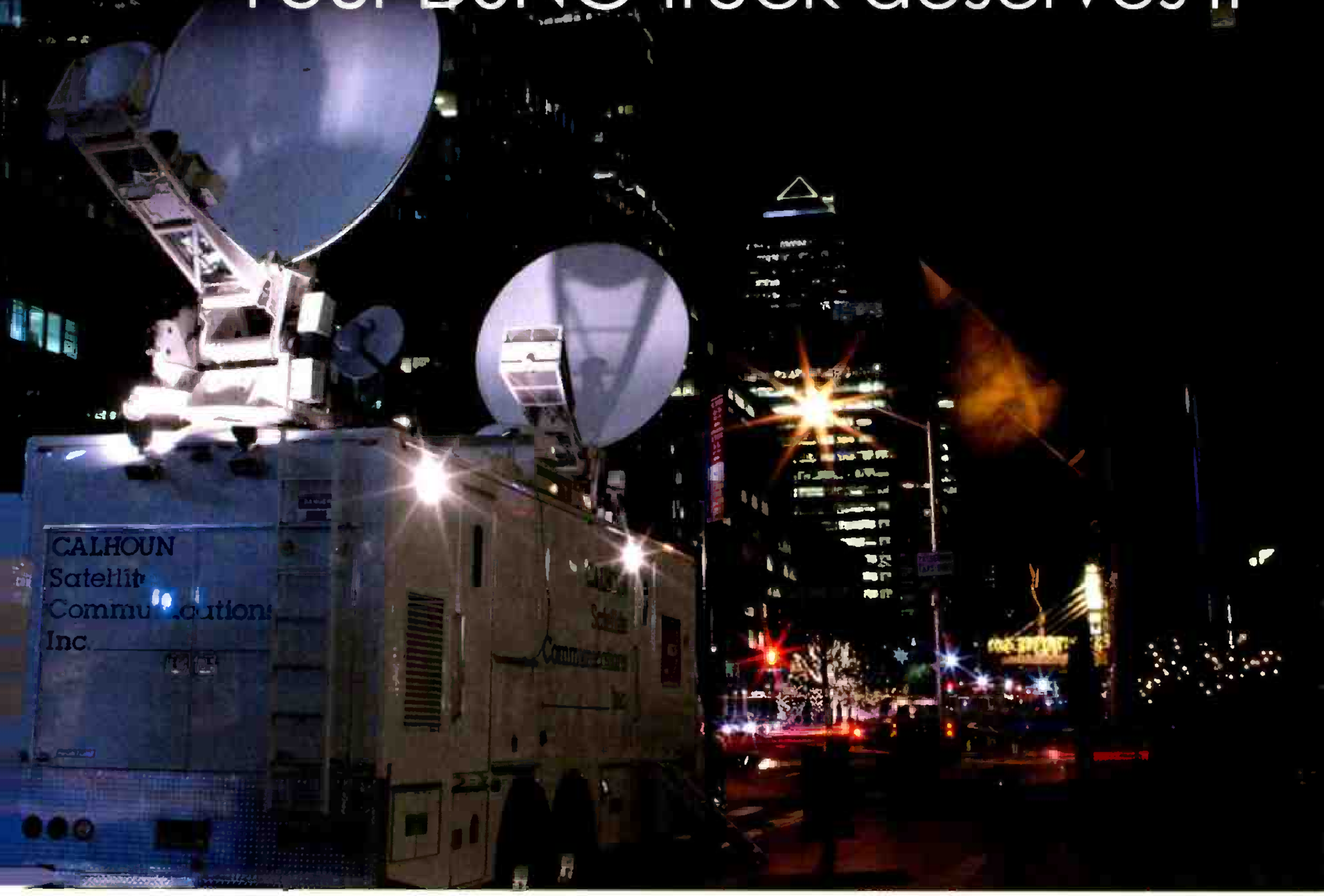

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The development of specialized chips that enabled the complex calculations needed for MPEG compression to be done on single boards changed the dynamic completely. As solutions became more compact and less expensive, people began to experiment with more marketplace uses, which drove up volume and drove down prices. Early MPEG encoders cost an order of magnitude more than a decoder, and up to around 25 times as much.

Over the last two decades, that ratio has declined to perhaps 3:1 (professional decoders and encoders), and even less. Appliances for streaming content to the Internet can be purchased for less than a single decoder cost in the '90s. We have also seen decoder implementations in finished consumer devices sold at discount for a fraction of what one encoding chip cost 20 years ago.

HEVC

As it always seems to be, the dynamics are not much different today. This year, we will see the first HEVC (High Efficiency Video Codec) systems, which should lower bit rates by 30 percent to 50 percent. The complexity of HEVC is astounding, and implementations in silicon are perhaps the only way it can be produced economically.

To gain the advantages HEVC can offer, the cost of an encoder/decoder pair will jump up, which makes the most likely early deployments look like the backhaul market, again. This cycle is likely to repeat again in a few years, driven by the impact of consumer scale deployments. HEVC may be the next compression technology to arrive in consumers' homes. MPEG-2 has lived for two decades, H.264 is already approaching its second decade, and the early deployments of HEVC will certainly begin this year.

This dynamic repeats in many parts of our industry. Display technology intended for consumer deployment shows up first in professional uses, like flat panel monitors on set for productions, and later in consumers' homes as increased quantities drive prices down and widespread deployments bring new technologies to the edge where they mature and follow the same cycle.

We have become an industry dependent on the infusion of development dollars into potential consumer technology, which then trickles into our small corner of the economic puzzle. **BE**

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Employment

JOINT MASTER CONTROL OPERATIONS CONTENT MANAGER/MASTER CONTROL OPERATORS

JMCO, operator of PBS's first joint master control environment and an affiliate of WCNY, in Syracuse, NY, one of the nation's most innovative non-profit, has openings for Content Manager/Master Control Operator positions for a new centralcasting operation that will serve PBS stations in NY, NJ and throughout the country. This position offers an opportunity for a self-starter with good communication skills who thrives in a fast-paced independent work environment.

The Content Manager will operate the systems that manage digital media assets and distribute material over various platforms, to support the operation of a multiple stream joint television master control operation. Candidates must have experience in a multiple stream digital media facility. Strong computer skills required. All inquiries should include resume, cover letter and salary requirements, directed to

hr@jointmastercontrol.org

JOINT MASTER CONTROL OPERATIONS MAINTENANCE/IT ENGINEER

JMCO has openings for Maintenance/IT Engineering positions for a new centralcasting operation in Syracuse, New York that will serve PBS stations in NY, NJ and throughout the country. This position offers an opportunity for a self-starter with good communication skills who thrives in a fast-paced independent work environment.

The JMCO Operations Maintenance/IT Engineer is responsible for all equipment operating at peak efficiency, ensuring proper operation of network equipment as well as broadcast equipment, creation, management, and execution of a preventive maintenance strategy and plan for hub facility and associated spokes, and make recommendations to the Director of Operations for system upgrades, capital improvements, equipment installations and equipment procedures.

Candidates must have experience in a multiple stream digital media facility. Strong computer skills required. Two (2) year EE degree or 7 years electronic experience or 5 years in broadcast TV and/or FM or equivalent combination of education and experience. All inquiries should include resume, cover letter and salary requirements, directed to

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