Broadcast Acquisition and Post-Production

Karl Paulsen, Azcar

with contributions from Larry Thorpe, Canon USA, and Bruce Devlin, AmberFin

During the previous year we have experienced the polishing of many technologies and implementations that were, due to their infancy, maybe a little rough around the edges. Even though analog over-the-air U.S. television is "gone," the legacy 4 x 3 footprint with its 480 lines of interlaced images remains for an eternity. It goes without saying that widescreen displays are now accepted, yet we continue to suffer from a less than complete implementation of the many ideas those visionaries of HD imaging hoped to attain. Even though the SMPTE and Advanced Television Systems Committee (ATSC) premise for Active Format Description (AFD) has yet to fully materialize from acquisition to release and display at the consumer level, we can still hope that over time the intention of the content creators will be carried forward to the end user in the ways, or means, that the images were originally intended.

With analog broadcast television mostly behind us, we can now take better aim at, and focus on, more targeted improvements for implementation. Going forward, we will begin to see and realize the virtues of these technological achievements; moving forward with advancements in the capture, manipulation, distribution, and presentation (i.e., display) of the moving image.

The 2008 Progress Report identified significant growth in HD for news, production, and consumer applications. At that time, and to supplement that revolution, systems needed to be deployed that could manage these new content formats. We have seen numerous favorable updates that encompass imagers, capturing and storage devices, editorial platforms, and file-based work processes that aid in taking digital content from source to destination. This year's Progress Report looks at some of those milestones—with apologies to those areas that just could not fit into the allowable space of the *Journal*.

ACCOMPLISHMENTS IN BROADCAST AND THE MOVING IMAGE WORKFLOW

Trying to summarize the state of the industry with respect to broadcast acquisition and post-production is a challenge. One could pick selected areas and hit on the high points while envisioning where technology (and operations) has improved over the previous 12 months, or approach from the content life cycle perspective where images that are first captured using lenses are migrated to an evolving non-tape-based storage platform, then follow the story where they are stored again or transmitted directly to a platform for consumption by an end user or colleague. Later, and now often simultaneously, that same material is repurposed for a differing platform and disseminated on another transmission medium to another set of users. All for the purpose of creating an experience that is of value to both the end user and the creator and that fulfills a message that is morally, socially, and hopefully economically achievable.

The term "broadcast" has evolved well beyond digital terrestrial over-the-air broadcasting, moving swiftly into the realm of multimedia content delivery on a global basis through an ever-expanding set of transmission mediums and delivery platforms. With this evolution, the lines of perception for image quality have become less definable and more dependent on the transmission methodologies employed. Yet irrespective of where content is viewed, or how it was delivered to that viewing portal, one thing is certain—the

Karl Paulsen is AZCAR's chief technology officer, a SMPTE Fellow, Life SBE Member and a frequent contributor to the industry in the field of broadcast systems engineering and media technologies. He is a feature columnist for *TV Technology* magazine and author of the book *Video & Media Servers: Applications and Technologies*, published by Focal Press. Paulsen's carrier spans more than 30 years in public and commercial broadcast television, post-production, and computer-graphics/effects at the operations, engineering, and management levels. Since 1995, he has focused on systems integration management, consulting, and advanced technology, beginning at Synergistic Technologies, and continuing when acquired by AZCAR in late 2000.

better the original content is captured (in terms of image quality), the better the chances are for an improved final product.

The moving media industry continues to search for improvements at all stages of this content life cycle. As progress is made in developing higher resolution imagers, recorders, and such; it is also being made in ancillary components that surround the overall broadcast acquisition and post-production chain. Most evident are the significant improvements in workflow, specifically in those tools that support an all-file-based production environment.

The improvements in HD camcorders and their supporting optic systems are evident as systems move toward 4:2:2 sampling, significantly improving the clarity of the color information compared to 4:2:0. Codec efficiency improvements in both temporal and spatial domains coupled to bit rates between 35 and 50 Mbits/sec now yield a much higher quality image at the point of origination. All of these improvements provide positive impacts to the post-production and repurposing processes further downstream in the content life cycle.

HYBRID IMAGING PLATFORMS

One trend seen in production is the merging of digital still photography and video onto a common platform. When looking for image capture devices that can do double duty some of the recent additions to this territory now include Canon, which introduced, last September, its full frame, 21.1 megapixel (5616 x 3744) EOS 5D Mark II digital SLR camera—the first EOS with full HD 1920 x 1080 video capability at 30 frames/sec. With a 4-GB maximum file size, the camera records up to 12 minutes of 1080p H.264 QuickTime (.MOV format) at a data rate of 38.6 Mbits/sec with PCM sound.

Panasonic's Lumix DMC-GH1 with its 12.1 megapixel imager records both 1080p24 and 720p60 HD video. Using Panasonic's Live MOS sensor, continuous autofocus and built-in Dolby Digital Stereo Creator; Panasonic's designed-for-video Lumix G Vario HD (14 to 140mm) lens supports a multi-aspect ratio function that allows photos to be taken using a 4 x 3, 3 x 2, or 16 x 9 aspect ratio with the same angle of view. In addition to QuickTime motion-JPEG images, the DMC-GH1 records 60 frames/sec HD in AVCHD (MPEG-4/H.264) format. The 1920 x 1080 HD movies are output by the image sensor at 24p NTSC (25p PAL) and recorded at 60i NTSC (50i PAL).

Directors, digital cinematographers, directors of photography, and production professionals in all industries have discovered new uses for these cameras such as production framing and blocking checks, lighting, set continuity, prop/dressing placement, and the like. Others are using these cameras in place of conventional HD-video/recorder units, finding them to be an effective and progressive means to gather HD images suitable for editorial purposes. Production personnel from amateur to professional now can employ a single digital-SLR camera, coupled with interchangeable lenses, for capturing HD-clips and then instantly shift into taking stills without any hesitation.

LENSES FOR HIGH-DEFINITION AND BEYOND

As images get larger, sharper, and more critical, the requirements for high-resolution lenses get more definitive. For sports applications, focus is critical and automatics have become a key element of importance operationally; now progress is being made in auto focus for studio lenses. Canon placed its TTL-Secondary Image Registration Phase Detection technology in its new XJ27x6.5B AF HD studio lens. The phase detection technology divides the incoming light into a pair of the secondary imaging lenses focused on separate sensors, which then compares the two images to resolve focus parameters for the primary image.

Field cameras utilized in news and location time-sensitive productions continue to advance in performance and features. To keep pace, Canon introduced a third-generation HD portable EFP lens, which exploits new glass materials, new advances in optical anti-reflective coatings, and pushes both focal range and wider angles in their new HJ14ex4.3B (presently the widest angle 2/3-in. lens in the world). The lens is noted for its higher MTF, enhanced contrast ratio, and better control over optical artifacts stimulated by strong light sources (e.g., studio lights or the sun). Accompanying the lens is a new digital drive unit that will be used on all future portable lenses.

Notable are new software platforms that incorporate two distinctly different Chromatic Aberration Correction (CAC) systems that work in concert with unique firmware systems in certain HD cameras. One, for use with the established CAC system in Panasonic cameras, and a second for use with the new Automatic Lens Aberration Compensation (ALAC) system in Sony HD cameras. Chromatic aberrations are those fringing artifacts noticeable on some HD lenses.

ACQUIRING CONTENT INTO A FACILITY

It is rare to find any facility that has the luxury of having all of its content delivered in a single, unified format that is free from flaws. Camera equipment and tape/file delivery of content often results in a variety of physical formats and an even greater variety of wrappers and compression formats arriving at the front door of a facility. Efficiencies in the workflow process can be achieved if a common versatile wrapper is used within the facility and those efficiencies are enhanced if a common compression codec can be maintained throughout as much of the facility as is possible.

Today, the engineering function called ingest is often used to describe the acquisition of an (HD)SDI stream into a file-based workflow. Leading-edge companies, however, are using products such

as AmberFin's iCR to define the business process of ingest as the process of taking material through a quality control (QC) quarantine zone so that it becomes a revenue-generating asset. The trend is for this process to take place into central storage rather than for ingest to take place onto a playout server. Automating the QC process during stream ingest or file transcoding allows the value of the media to be maximized while keeping costs at a minimum.

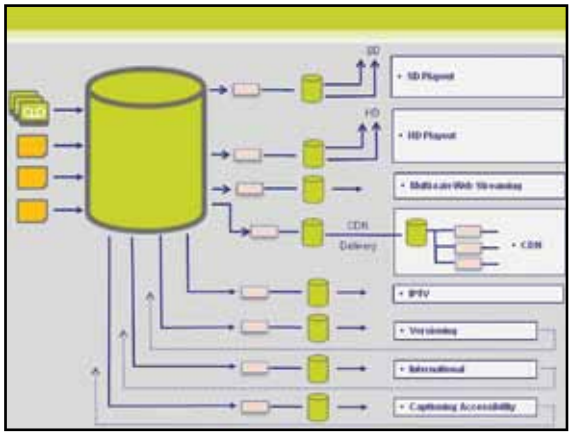

Figure 1. The emerging content dissemination paradigm from AmberFin's iCR permits differing transcode procedures to be handled in an identical way, with a consistent interface that can create customized workflows using a commodity product.

For SD workflows, 50-Mbit/sec I-frame MPEG in an MXF wrapper is becoming the de-facto intermediate format. For HD, there is currently no "winner." MXF is becoming the de-facto wrapper standard, with QuickTime and AVI following close behind. Codecs range from high bit rate, 10-bit JPEG 2000 at the high end to low bit rate MPEG 4:2:0 at the low end. AVCIntra, DNxHD, Pro-Res, I-frame MPEG-2, HuffYUV, CineForm, Long GoP H.264, and Long GoP MPEG-2 are all used in workflows around the world.

With such a vast plethora of HD codecs in use, it becomes increasingly important to choose a common wrapper so that equipment can work, where possible, at the wrapper + metadata level. MXF is fulfilling its design goal in this area. New OP1b representations for use within a facility (such as the AS02 application specification from AMWA) and OP1a representations for use between facilities (such as the AS03 application specification from AMWA) help users minimize costs while maximizing interoperability.

AUTOMATION CONTENT ANALYSIS AND VERIFICATION

File-based workflows now dictate a dependency on file analysis to protect the asset, validate compliance, and ensure proper preparation per the expectations of the content originator. The plethora of file formats has made it impractical, and nearly impossible, to ascertain compliance with format standards and specifications without tools that can automatically analyze the inner components of any media file for conformance. Similar tools have been available for analyzing the transport characteristics of ATSC or DVB transport streams for some time. Now operators can obtain a tier of analysis tools that specifically address media-centric files and look at video parameters such as color space and depth, video format, profile and level, bit rates and frame/field mode; video quality issues including blockiness, clipping, black or missing frames; and audio issues such as silence, loudness, and phase.

Given that human observations are generally inconsistent, software and hardware solutions from Tektronix (Cerify), Harris-VideoTek (QUIC), Interra Systems (Baton), and Venera Technologies (Pulsar) now provide a customizable set of tests and checks that define,

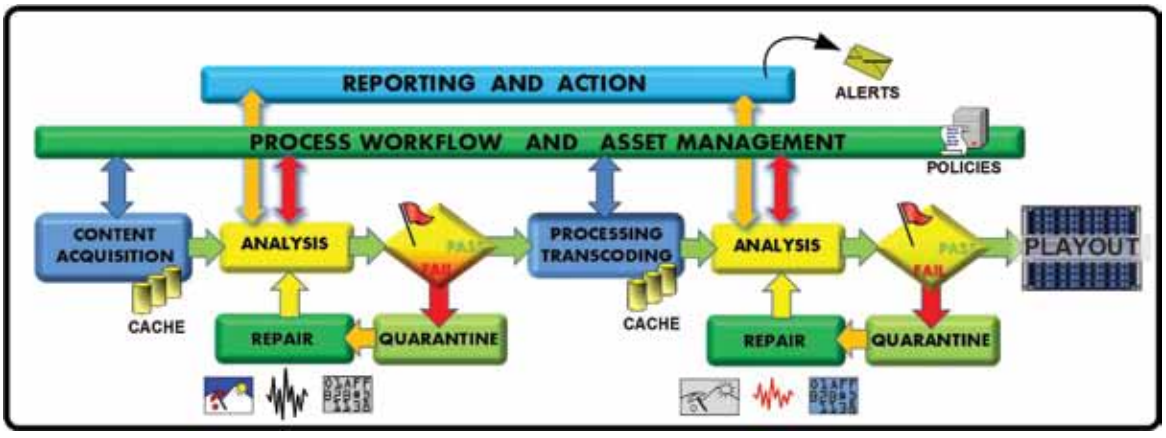

Figure 2. File-based quality assurance, analysis, processing and reporting workflow for media content.

rank, and flag conformance and quality issues before a file is permanently damaged or, more importantly, before it is released for live or other distribution platforms.

Besides file-based analysis of digital media assets, 2009 saw further improvements and additions to the tool chest that aid in realtime video and audio quality assessment. Technologies designed to grade, identify, and even correct for anomalies that occur in areas related to audio/video synchronization (lip sync), video display characteristics, processing errors, and compression artifacts or concealment are currently available from Video Clarity (ClearView), Sarnoff (Visualizer Digital Video Test Pattern), and others.

Video and audio delay correction remains a hot topic for broadcasters and consumers alike. Today, software and hardware products are available as terminal equipment or component options from Evertz, Miranda, Snell's Vistek, and others. These systems are designed to detect and report so called "lip sync errors;" and may be employed as in-service (non-disruptive) applications or for out-of-service uses (which could be either disruptive or non-disruptive to the signal itself). Ideally these dual ended systems will ultimately provide end-to-end realtime correction of video or audio delay through techniques embedded into the video terminal processing gear available from each respective vendor.

THREE-DIMENSIONAL ACQUISITION TOOLS

Beyond the camera and lens requirements for capturing 3D-stereographic images come new adaptations for mounting equipment and adaptors necessary for handling and maneuvering these often oversized devices. Prominent this year are commercial devices that go beyond the one-off custom versions manufactured for these once unique applications. P+S Technik continues to develop its package of components dubbed the "3D Stereo Rig," allowing users to adapt pairs of the prominent manufacturer's cameras for shooting.

In addition to the hardware support, 3D viewfinder/monitors, such as Transvideo's CineMonitorHD 3D View, allow directors of photography to properly correlate cameras and preview the results in anaglyph mode. 3D acquisition further requires new tool sets (e.g., Binocle Disparity Tagger) that can visually alert the operator of unacceptable disparities caused by too much out-of-the-screen effect or background offset, depending on the size of the viewing screen used. Furthermore, when capturing 3D-stereo video, every frame in every shot needs to contain the precise lens and camera settings such as focus setting, T stop, and depth-of-field. Progress continues in the lens and electronic control products that aid in 3D acquisition, for example, Cooke Optics Ltd.'s product, utilizing its "/i Intelligent Technology," automatically generates metadata from appropriately equipped lens, which is fed remotely to a time synchronized (often time code based) metadata recording system. The data is later used in post-production for correction, positioning, and CGI work.

POST-PRODUCTION

It is apparent that software-based post-production is the norm and no longer the exception. Following years of development and refinement, the nonlinear-editing process is now squarely set in the direction of an all file-based post-production environment with advances in native and conversion-free realtime access to MXF variations.

MXF Firmly Established in Post-Production

The past years have seen advances in MXF accompanied by sets of metadata being implemented by many providers of acquisition and editing solutions. With this combination have emerged software applications that support MXF (plus metadata) at a level not seen previously.

The Apple Mac editing platform is already working in this territory using products formulated specifically for MXF from companies such as Hamburg Pro Audio. The company's MXF 4mac products, like others, use MXF import and MXF export solutions that enable QuickTime and QuickTime-based applications to handle MXF content by providing format components that integrate seamlessly into the multimedia architecture of Apple's OS X for Mac. Compatible applications, such as Final Cut Studio, will utilize these types of applications as post-production solutions.

As the focus on P2 (P2HD) and XDCAM (XDCAM HD) workflows continue, software applications that move P2/XDCAM-metadata into nonlinear editing platforms (e.g., Final Cut Pro and Avid) are growing in popularity and becoming a necessity. Post-production requirements now emphasize the importance of features such as unwrapping and re-wrapping, or the conversion of QuickTime compatible media to standard MXF in D10 (IMX 30/40/50) as built-in applications, plug-ins, or third-party applications.

Export plug-ins now directly convert one MXF operational pattern into another pattern. Metadata synchronizers now update metadata contained in the MXF files without recreating the file via an in-place operation, preventing the separation of essence from metadata. Partial restore routines let the editor create a cut-out version from the original file while preserving the relevant metadata, thus keeping user information with the media file at all times.

As with many advancing technologies, the burden is on the user to understand, select, and utilize the various applications and tool sets to successfully fulfill their own systems' needs. This rapidly changing prescription is emphasized by the emergence of both professional and consumer level encoding formats that continue to surface on the media horizon.

On a larger scale, IBM is breaking down the cross-platform, cross-codec confusion when users stay in an all-MXF environment. By combining their MXF-server and GPFS platforms, the mixing of Avid, Final Cut Pro, and Adobe software suites into a single harmonious working environment has been demonstrated. IBM's General Parallel File System (GPFS) incorporates high-performance enterprise file management, allowing the user to move beyond simply

adding storage to optimizing data management. The MXF-server intends to homogenize multiple editing platforms allowing them to see all of the working MXF files at any workstation.

AVC-Intra Adoption

The professional advanced video codec, based on H.264, comes in two similar looking names—for what are two entirely different codecs. AVCHD is the long-GOP consumer format developed by Canon, Panasonic, Sony, and others. AVCHD is sometimes misrepresented in the context of the professional version, which is known as AVC-Intra.

AVC-Intra is frame-based compression. It does not reference other frames as part of a group of pictures. AVC-Intra 100 is mastering quality, with AVC-Intra 50 (50 Mbits/sec) providing video quality similar to that of DVCPRO HD (at 100 Mbits/second). Broadcast news and production has begun to use AVC-Intra for its HD acquisition, at half the bit rate, using ENG-grade professional cameras.

As a codec, AVC-Intra is being adopted by several video server and editing manufacturers' product lines; a partial list includes: Apple's Final Cut Pro 7 (providing native AVC-Intra decoding within a ProRes 422 timeline), MainConcept (AVC-Intra encoder and decoder as part of their Codec SDK), Harris NEXIO AMP, Grass Valley (in the EDIUS version 4.5), Quantel, Omneon (Spectrum and MediaDeck), and others.

Live and Automated News Production

With the sights of broadcasters aimed clearly at cost management, the development of automated live studio news production systems has accelerated. Live studio news once required multiple technical and production level personnel, each with individual tasks, to facilitate the actual live-to-air broadcast production. Today, those individual operators' tasks are being reduced to a minimal number. Camera operators have been replaced by robotic pedestals and PTZ (pan-tilt-zoom) camera systems. Audio and video (vision) mixing control surfaces have been replaced by computer-controlled platforms. Art, graphic, and text-base character generators, once several sets of discrete components, are now reduced to a single device. An entire control room of live operators has been reduced to one, two or three people, with the director, technical director (TD), and audio functions being performed by a single person operating a control surface that handles all the elements in a graphical-user interface.

Reliable interfaces, coupled with intuitive software for the users, and linked with plug-ins and control protocols (i.e., MOS), has resulted in entire platforms of automated solutions for live news and production.

Serving Platforms and Storage

This past year saw augmentations to the integration of disk-based storage that acquire, process, store, playback, and brand video on its way to transmission and now provide a definitive course of deployment for adding new broadcast services. Omneon's MediaDeck has supplemented their HD or SD offering with integral graphics (by Pixel Power) and audio processing (i.e., decode and encoding of Dolby AC-3 and Dolby-E)—dubbed MediaDeck GX. The Harris NEXIO suite added features and branded their server as an "Advanced Media Platform" (AMP) offering storage protection, integrated software codecs, and automatic up/down/cross conversion for complete format transparency. NEXIO supports MPEG-2, IMX, XDCAM HD, and DVCPRO HD formats and provides a variety of solutions for production, on air, newsroom, and transmission operations.

Sports and news production requirements are further driving the integration of video servers as clients. The Grass Valley K2-Summit product provides many of the required functions, including HD super slow-motion, and simple transitional effects, all from a single chassis. With the rapid acceptance of multi file formats, it is not uncommon (as is the case with K2 Summit) to find MXF, GXF, and QuickTime files interchanged on this and other platforms.

The expanding set of server platforms include specialty self-contained systems as videotape transport replacements but include feature sets that integrate with high-performance storage and archive management systems. Sometimes thought of as "appliances," the videoserver is now becoming the conduit between realtime baseband I/O and file-based production activities. SeaChange International débuted a small form factor media server that integrates with third-party storage, file systems, and workflow solutions. Express Video Supply (EVS) continues its production and live server-based platforms integrated with nonlinear editing and replay systems; as does 360 Systems, which added an HD-videoserver/VTR-replacement platform to its SD offerings.

With a combination of silicon and software, configurable software codecs, and external storage resources, the progress made by the videoserver media platform has changed the way live (realtime) and post-production workflows occur. Flexibility starting at the field acquisition level is allowing this merger to occur as content moves from the field and onto the post-production highway.

Higher Resolutions Yield High Performance Storage Management

Once again, the video industry has been brought further into the domain of the IT industries. The acceptance of HD brings the next generation of acquisition and production, the emerging collection of "true" and "super-HD" formats ranging from 1080p/24 and 60 upward to UHDTV at 16 times the HD resolution. Progress in film and digital cinema has already embraced 2K and 4K resolutions.

Video production switcher manufacturers are switching to internal 1080p60 processing. And now, Super Hi-Vision with 7680 horizontal pixels and 4320 lines is about to land squarely on the heels of the awaiting storage industry.

What this means for storage and for compression is a quantum leap for the processes of capturing the image, compressing it to a manageable size, storing it onto spinning disks and/or tape systems, and moving it from one point to any number of other points. Several groups within the SMPTE standards community are now focusing on this transition, including the development of 24 Gbit/second transport, 10 Gbit/sec interfaces (SMPTE 435), and even a look at 40 and 100 Gbit infrastructures.

When these challenges are combined with workflows that demand collaborative post-production across geographically separated regions, this results in a new set of needs in management and handling of digital assets. Technologies that were once either hidden inside the storage platform or limited only to the transactional world of data-centric systems are now coming into the view of digital video post-production and acquisition. Concepts now being deployed to control the rising volume of storage solutions include such practices as data migration in which data is moved from high-performance/high-cost Fibre Channel disk storage to lower cost SATA and iSCSI drives with a policy-based set of parameters. Backup and data migration processes now include duplication to safe storage platforms (remote or disaster recovery sites) and to linear data tape for archive purposes.

With multiple applications creating multiple versions of the assets, and the desire to protect all of those assets in the event of data corruption or file locking, the practice of data de-duplication has emerged from the data center into the media central equipment room. Data de-duplication is a process of intelligently marking or tagging all of the digital assets and then removing redundant copies of those files or elements, creating only a single asset with pointers from all of the previous locations to this single version location. The process significantly reduces data storage requirements and allows for multiple sites to have access to a single common set of data, reducing LAN/WAN bandwidth requirements for asset management and protection or backup.

Content Delivery Networks

The collaborative nature of post-production now demands the implementation of secure, reliable, and effective high-speed delivery of digital media assets. In recent times, service provider businesses have risen out of the need to provide a controllable quality of service (QoS) delivery platform that works on either public or private networks. The transport of such files used to require special configurations of the carrier's systems to enable the most rapid and efficient means for delivering files to one or more sites concurrently. That model is changing.

From these service provider businesses, media-focused manufacturers developed solutions that enabled the management of traffic and data flow over IP-networks—now referred to as a content delivery network (CDN). Based on policy-based workflow applications, the CDN now brings together file-transfer, prioritization, scheduling, security, and acknowledgment (including partial refeeds of missing packets or segments) using both unicast and multicast delivery methods.

In conclusion, progress in media content acquisition and production continues in every dimension. As IT and moving media move closer together, these improvements will continue. As videotape uses continue to decline and content types and uses expand exponentially, it is difficult to tell what the next years will yield in terms of technological advances. One thing is for certain—the uses of the moving image for telling a story will not be declining any time soon.

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