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ESSENTIAL GUIDE BroadcastEngineering.

Automating Quality Control in File-Based Workflows



rom the day most television stations first signed on, nearly all eyes at the stations focused on one channel. In control rooms, studios and transmitters, engineers constantly monitored video quality in real time. Professional video picture monitors were often used for critical observation. Trained and licensed broadcast engineers used calibrated waveform monitors and displays to necessarily verify standards compliance and to measure and adjust technical variables.

Tektronix' founders invented the world's first triggered oscilloscope in 1946. Soon after, Tektronix began manufacturing specialized test and measurement tools for television broadcasters, based on the triggered oscilloscope. The new equipment allowed TV stations and facilities to more easily ensure that their signals adhered to NTSC and FCC standards, so everyone who could receive their broadcast signal could see their programming. Even with the best waveform monitors, these checks were visual and therefore subjective.

The Human Factor

In earlier times, two, three or more broadcast engineers simultaneously monitored one channel's video and audio signals in real time. If one engineer blinked, another would likely catch a glitch. Quality control was simple when everyone in the facility



focused on one channel and the sources were studio cameras, network and film. As videotape replaced film and color became standard, quality control issues skyrocketed.

The spontaneous industry-wide solution was to randomly spot-check a videotape to verify its playback quality right after it was recorded. Spot-checking worked well with short commercials, but longer programs were less likely to be thoroughly inspected head-to-tail. Content problems were usually caught during on-air playback, duly noted in the daily discrepancy report and fixed as soon as possible. Before multi-channel digital television, most facilities were generally satisfied with manual quality control (QC) methods.

In today's bandwidth-hungry 24/7 operating environment, DTV sub channels, streaming and on-demand Internet video allow a single facility to program multiple channels and deliver them to multiple audiences. Viewers expect the quality of a station's brand to be consistent across platforms, channels and sub channels. Consistent quality demands QC. But, the ever-growing, ever-changing content explosion increases loads on IT infrastructures and goes beyond what any kind of human QC system can economically handle.

The value proposition of an automated QC system is to provide 100% coverage of all content at a fraction of the price it would cost to do manually. Automated QC helps get 95% of necessary QC work done in an automated filebased environment. The remaining 5% will continue to require humans because there are some artistic things in the video and audio that an automated system may misinterpret as a problem. When humans QC, they listen to the audio, observe the video and make the pass-or-fail call. What humans inspecting programs can't see is the aggregation of ancillary digital data required to make the content a valid digital file.

The quantity and quality of video files is exploding while the number of people handling and critically verifying their quality before streaming or broadcast is shrinking. More channels with fewer critical eyes watching for problems increases the risk of real viewer complaints.

Broadcasters need reliable test products and methods to objectively verify the technical quality and compliance of video streams to industry standards. As stations learned during the transition to videotape, new technologies can introduce significant new quality control issues and technical challenges.

It is not unusual for a digital television facility to process hundreds if not thousands of video files every day—not just the original content, but also the same content to be streamed over mobile video and the Internet in dozens of formats and bit rates. Adaptive bit rates may introduce several variants of the same file encoded at different bit rates, when they are re-encoded into smaller files. All these files need to be thoroughly checked and verified before viewers see them. Sometimes, it's more than humans can handle.

File-based work flows create new needs

File-based video starts as a Serial Digital Video (SDI) signal, which is encoded into a compressed format while it is tweaked and monitored on a waveform monitor for baseband technical variables such as gamut errors and audio peaks. The compressed video file is wrapped with audio tracks, time code and other metadata and then ingested into a video server. Content is usually quality checked postingest for artifacts.

Encoded files are stored in near-line storage. Near-line (meaning near-online)

SBS Broadcasting Networks, UK have been using Cerify for the past three years as part of their UK Playout Centre. Over 200,000 video clips have been processed by Cerify before deployment on our 12 channels broadcast from our Chiswick site.

Cerify has enabled us to scale effectively by managing the increased throughput of adding additional channels. Cerify is integrated into S4M's VMPS workflow system using its SOAP API. This integration enables the Quality Control Department to primarily focus on pictures and editorial content rather than technical QC as this is delivered effectively by Cerify. As a result, we have improved the technical quality of our output and have reduced errors downstream of ingest.

 Ricki Berg, Head of Benefits, SBS Broadcasting Networks



storage supports frequent, rapid file access. Near-line storage usually contains a cache of content to be played out in the next 24–72 hours.

The playout server can create a transport stream, or create a baseband signal for encoder/transmitter input. SDI signals are monitored with waveform monitors for audio loudness, closed caption compliance, etc. Digital broadcast is monitored in real-time with transport stream monitors on IP and RF interfaces.

Typically, on-line and near-line storage systems use Network-Attached Storage (NAS) and servers dedicated to file storage and retrieval. They use standard network interfaces and standard file sharing protocols such as SMB/CIFS, NFS or FTP. RAID systems provide redundancy by combining multiple physical disk drives into a single logical disk drive. Clustering provides load-balancing of file requests and eliminates single points of failure.

High-resolution master files, known as

mezzanine files, can be transcoded and repurposed for delivery to different customers. Transcoding is invoked on demand by the user, or automatically by the media asset management (MAM) system. Quality assurance checks are usually made after editing and transcoding are completed.

Content is often moved to the archive after playout, or if ingest occurs far in advance of playout. Archive storage requires significantly higher capacity, and slower access is acceptable. It also includes non-disk media such as tape libraries and optical jukeboxes. "Deep archive" is often the term used for off-site storage for disaster recovery.

Content can be restored from the archive to near-line storage for repeat playout or editing into new material. Descriptive metadata saved with each file is used by the Media Asset Manager to search for programs and segments. Transcoding may be necessary if the archive format differs from working formats.



Figure 1: Architectural overview of a file-based workflow environment

Technicolor is currently using the Tektronix Cerify automated QC application in a number of areas within our Digital Content Delivery business unit. With the proliferation of both the raw number of files, as well as the scope and complexity of file types/variations, manual QC is no longer a sole option for our delivery process. A robust and capable mechanical QC system is a required part of the workflow of any high-efficiency digital delivery supply chain in today's market. We have found the Cerify system to be applicable both for certain levels of fully automated QC as well as serving as a 'pre-selection' device for follow-on human QC, thereby improving the efficiency of the manual QC process.

Ed Elliott,
Sr. Solutions Architect,
Technicolor Digital
Content Delivery.



Most file-based video starts as baseband video, and its compliance to baseband specifications is critical as it is ingested as a file. It is the last chance to make crucial picture adjustments and real-time quality control. However, a multitude of new threats to program quality lurk in the digital domain.

Syntax errors cause problems. A syntax error is a glitch in the order or structure of ancillary data necessary for a file to comply to a specific industry standard. Syntax errors can be virtually invisible to the human eye, yet they can cause significant problems or even failures in storage and delivery systems. Only by analyzing each file with automated QC systems specifically designed to do so can a QC system detect the kinds of errors that occur in file-based video systems. Automated systems can aggressively interrogate file structures and syntax as they reside in off- and online servers, and report or automatically correct problems.

Broadcasters are faced with a wide variety of technical challenges and workflow changes. Complicating the process are continual updates in technology prompted by new digital CODECs and formats. Regardless of the CODEC or format being used, success depends on content quality and consistency.

It is crucial to ensure that each content file conforms to technical specifications so it does not cause problems in the digital ecosystem. If the content is not syntactically correct, it can wreak digital havoc, such as corrupting a playout server or freezing or resetting set-top boxes. Syntax testing is an essential new requirement for file-based QC.

When spot-checking content through a play out server or using a generic playback application, different decoders handle syntax errors a bit differently. Errors that may be gracefully handled by



Figure 2: "Slice order" errors in MPEG transport streams can cause blockiness and other picture distortions.

the player the QC operator is looking at might cause problems that annoy viewers using a particular set-top box.

One particular VOD operator began receiving viewer complaints because some VOD programming was ending prematurely. The VOD operator was not aware of the issue because it didn't have someone checking thousands of theatrical movie inventory from beginning to end making sure each file was intact. It took a viewer to call and say "Hey, the last 15 minutes of my movie are missing. What's wrong?"

The problem was revealed by a Tektronix Cerify QC system through the syntax checking. Cerify checked the syntax of thousands of files in the VOD operator's library and found a handful that ended prematurely. The problem was that the problem files didn't have the proper closing flags at the end of the file. The files were re-ingested and the problem was solved. The point of automated testing is to identify syntax errors and myriad other digital problems before they become viewer complaints.

Quality Control Choices

Typically, stations receive news content and material from advertisers and syndicators by satellite, microwave or Internet, in data files or baseband to be encoded and ingested as a data file locally. Once ingested, the data file can be QC checked in one of three ways. Most basic is to verify encoder type and bitrate and visually evaluate program quality on a monitor. Not only can this method be the most expensive, it is also the most ineffective.



The next step up, and vastly more popular, are transcoders that pre-integrate a QC solution as part of a QC infrastructure in the ecosystem. The concept sounds good, but self-testing transcoders typically use the same code base for the QC engine as their transcoder engine. They can't check for critical interoperatibility issues and they don't check for syntax errors. They will propagate errors they can't identify.

Some transcoder vendors have recognized the shortcomings of pre-integrated QC. Instead, they are creating an infrastructure or architecture that can take advantage of more powerful external stand-alone QC solutions. Thus, the third and best solution is a standalone solution provided by a QC-only vendor such as Tektronix.

Analogous to the waveform monitor and baseband checking, some products incorporate vectorscope and waveformdisplay-type functions in, for instance, editing or color correction software. Professionals trust standalone monitors more because their resolution is greater than the virtual displays that are integrated with most operational systems. That's why standalone baseband monitors continue to sell well.

Broadcasters are learning that a transcoder vendor's QC solution within the workflow is not enough. Once the transcoding and ingest is complete, before the content is approved for playback, it needs to be checked by a full QC solution, such as Tektronix Cerify.

Tektronix Cerify Heritage

Tektronix television waveform monitors have been the industry standard for over 60 years. This rich heritage of television test & measurement leadership is built into every Cerify system.

Cerify's internal codebase shares a common heritage with other Tektronix



Figure 3: This report from the Tektronix Cerify automated QC solution has captured an audio error and documented all of its parameters.

test & measurement and MPEG analysis solutions. It is designed from the ground up to be an error-checking analysis solution as opposed to being an add-on designed to catch some simple data errors.

Competitors in the standalone analyzer space have no experience in a true video test space. As such, they tend to be more software-centric. Some do a fair job at some of the more basic checking, such as testing a file for compliance to a certain format specification such as MPEG-2, H.264 or MXF container specifications. However competitors without actual video test expertise are at a significant disadvantage. Video test expertise is the critical advantage unique to Tektronix.

Tektronix has solutions in its portfolio that have technologies used within other parts of the product. Tektronix picture quality analyzers are considered the reference instrument for picture quality analysis in both "no-reference" as well as with "single-ended" type of measurements. Tektronix waveform monitors continue to be the defacto standard in the industry. Tektronix VQS1000 MPEG video quality test product has received world-wide acclaim, as has the Tektronix MTS4000 MPEG analyzer. Cerify binds and integrates all of these technologies together in one product.

The hallmark of a great test solution is consistent accuracy. Tektronix takes pride in ensuring that the measurements of its core waveform monitoring technology are consistent with Cerify's digital measurements. Cerify development teams and core product engineers shared code and expertise in its design to achieve this goal.

Tests performed on video files through Cerify will match SDI output measured with a calibrated Tektronix waveform monitor. The fact that Cerify is consistent with the defacto standard is a major factor guaranteeing confidence in the solution.

Only Cerify can properly test and measure server file content with consistent results. The integrity of the test, the accuracy of the measurements and the repeatability of the measurements is the critical difference that makes Cerify unique. There is no ambiguity because files checked by Cerify only need to be tested once.



Integrating Video Quality into a Broadcast Management System

urner Entertainment Networks (TEN) successfully implemented multiple instances of the Tektronix Cerify system, the world's first fully automated system capable of verifying the quality of file-based, compressed digital video and audio content prior to transmission. TEN has one of the world's largest all-digital broadcast facili-

ties. Cerify ensures the quality of broadcast through consistent and thorough checks of incoming compressed digital video. The automated monitoring provided by Cerify ensures that digital content meets TEN quality standards.

Manual inspection is resource-intensive and can be prone to error. Cerify is the only automated product that fully tests all aspects of a digital audio and video file to ensure that it meets system parameters, formats, resolutions, bit-rates, video/audio quality levels, metadata and compliance/correctness to a wide range of specified video and audio standards. Cerify can automatically check all of these, providing a repeatable, objective, and cost-effective testing methodology.

"TEN has now implemented a dozen Cerify systems to support our several broadcast properties such as TNT, TBS, Turner Classic Movies, Cartoon Network and Court TV," says Naveed Aslam, Senior Director,

Broadcast Technology & Engineering, TEN Network Operations. "In the analog world it was relatively easy to find a drop in audio or hits in the video. This is a much more difficult proposition in a compressed file-based domain. Cerify is able to quickly find problems automatically based upon the parameters we specify so that we can maintain our high-quality broadcast output."

An Aid to Workflow

In the transition from tape to digital ingest and server-based storage, broadcasters are faced with a wide variety of technical challenges and changes in workflow. Complicating the process are continual updates in technology prompted by new digital CODECs and formats.

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—Naveed Aslam, Senior Director, Broadcast Technology & Engineering, TEN Network Operations Regardless of the CODEC or format being used, maintaining content quality and consistency is critical for commercial success. TEN implemented Cerify with the Morpheus Quality Control (QC) Manager from Pro-Bel to form an integrated video quality and broadcast management system. The combined systems provide the seamless management of ingest and transfer of assets in the broadcast workflow.

"The integration of Tektronix Cerify and Pro-Bel Morpheus systems has become integral to our workflow," adds Aslam. "The integration enables TEN to perform fully automated, high-performance quality checking and management of our media assets. This ensures that all ingested material is correct and ready for scheduling and playout." Links between the Morpheus QC Manager and the Cerify web-based user interface provide a status overview of files ingested on the video server network and enable TEN to drill down and view file de-

tails and information about any quality errors and their exact location, right down to individual frames in the video and audio. The combined systems provide the seamless management of ingest and transfer of assets in the broadcast workflow.



No Compromises On Your Video & Audio Content Quality

Automated Quality Control for Your File-Based Content

No compromises on your video and audio content quality. Video ingested from different sources, encoded at different bit rates and formats and utilizing different compression standards presents considerable challenges to QC teams. Cerify[®] is a fully automated system for verifying/checking file-based content prior to transmission or use.

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	suit Name	JobStatus	Progress	MediaSet	Profile	Priority	Files	File Size	Creator	Status	Start Time	Copy
	Commercials MPE0-2 03-25- 05	Complete	100%	Commercials 03-25-05	Commercials	Medium	2	32.63MB	admin	Active	2005-03-18	0
	Commercials MPEO-2 03-27- 05	Complete	100%	Commercials 03-27-05	Commercials	Medium	2	32.63MB	admin	Active	2006-03-18	Rb
	Documentary Channel 03-12-	Complete	100%	Documentary Channel 03-12-	Documentary	Medium	1	6.16M9	admin	Active	2006-03-18	
	Movies MPEG-2 04-01-05	Complete	100%	Movies 04-01-05	Movies	High	3	41.30MB	admin	Active	2005-03-18	86
	Movies MPEO-2 Mar-05	Complete	100%	Movies Mar-05	Movies	Medium	3	41.30MB	admin	Active	2006-03-18	Q2
	News MPEO-2 03-21-05	Complete	100%	News 03-21-05	News	Low	4	32.84MB	admin	Active	2005-03-18	0
	News MPEO-2 Mar-05	Complete	100%	News Mar-05	News	Low	4	32.84169	admin	Active	2006-02-18	80
	Sports MPEO-2 03-15-05	Complete	100%	Sports 03-15-05	Sports	Medium	2	33.34MB	admin	Active	2008-03-18	80
	Sports MPEG-2 Mar-05	Complete	100%	Sports Mar-05	Sports	Low	2	33.3410	admin	Active	2006-03-18	8
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Tektronix Cerify® File-Based Content Analyzer

- Correct Encoding Syntax
- Correct Encoding Parameters
- Quality Levels
- Correct Ancillary Data
- Audio Loudness Correction



For more information, call Video Sales for a product demonstration at: **+1-503-627-2980**

www.tektronix.com/cerify

