Challenges of Quality Control for File-Based Video

Storing and manipulating compressed, file-based video/audio affords tremendous speed and savings but Operations is discovering how difficult it is to ensure correctly repurposed files are reaching broadcast and content-on-demand audiences. When formats and files accumulate, automated Quality Control (QC) and other workflow integration techniques can improve efficiency. There are many questions to ponder as you think about your own file-based quality control strategy.

Tektronix®

Whether you are a Broadcaster, Content Services Provider or Content Aggregator, today you have access to more file-based digital content than ever before. Format requirements for new delivery mechanisms are limited only by the audiences you choose to serve. Archives are growing every day and standards that you may need to soon support are still evolving.

Factors that could help differentiate one provider from another will likely include the perception of quality that the consumer sees.

Ensuring and optimizing file-based content quality means evaluating and reacting to media quality inside your network and understanding the impact your content can have on other elements in the ecosystem as well. It not just the audio, video and metadata that matter now, format and syntax are critical.

Throughout the video delivery chain, participants are evolving their workflow to support all digital environments. But because more and more content is compressed and archived in one format and then re-purposed to another format, archives are anything but homogenous, and working to maintain control over your facility s output can be more challenging than ever.

This white paper examines the key challenges facing managers who deal with the quality control of file-based video.

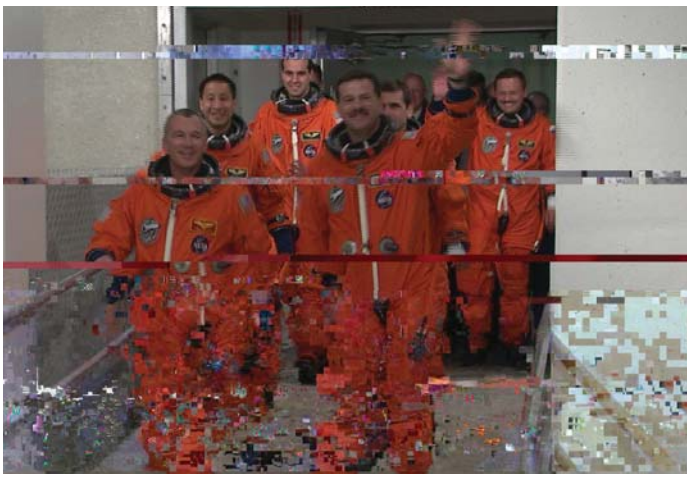
Key Concepts

- Many Operations Managers feel that the explosion of video files, format requirements and delivery choices is becoming unmanageable.
- Unblinking visual QC of incoming content is not comprehensive, fast, or scalable and has consequences for missing something important.
- A formalized content agreement between suppliers can reduce costly churn (rework of content) and often push the QC process upstream, saving you additional time and money.
- Automated, file-based QC can trap errors that humans cannot even see, scale with content growth, increase service quality, and get better leverage out of existing QC staff.

Can I still get away with simply spot-checking selected content?

As you will read, there are many reasons to check file-based quality - at a number of stages. Even if you begin with high quality video, compression and transcode failures at any point may cause transfers to stall, set top decoders to crash or even dead air. This can be costly. While every business is different, please consider your own situation and assign a dollar figure for each category to the right.

Opportunities or Considerations for Monetization	Your cost?
The cost of missed commercials - both refunds and ‘free’ replacement	
The ‘brand cost’ of transmitting poor quality content	
The cost of dead air time	
The opportunity cost of answering/fixing problems after they have occurred - often involving staff management time if an important content supplier is involved	
Quantifying the costs of lost subscribers	
Reducing the churn rate in digital mastering	
Giving refunds for a download with poor quality	
Reducing the number of people in the workflow	
Reducing end to end file time	
The cost of rejected content	



MPEG stream errors.

Today, is visual inspection enough?

In the past, the most common approach to QC was to have a small staff of people visually review the content (visual inspection). Even with a waveform monitor, these checks are, well visual and subjective. Realistically, you should only expect your QC staff to be able to see two main categories of technical impairments:

- Analog parameters of signal levels, like luma and chroma levels.
- Quality levels like black sequences, freeze frame, blockiness, loss of audio, video and audio playtime.

This visual inspection approach has proven effective when reviewing relatively small volumes of video content. But regardless of the strength of your QC staff, there are human factors to be considered during visual inspection:

- Visual and audio errors are easily missed, just by blinking or losing concentration for a second.
- Reviewers have a range of skill levels, experience and training which results in considerable differences among errors found by different observers.
- Staying objective is very difficult, especially over long periods of time, even while viewing similar content.
- Some content may have special considerations (e.g. adult entertainment).
- It is tiring to guarantee human visual inspection, day after day, week after week.
- Equipment used in visual inspection may differ by QC station or site, leading to inconsistent results.

What errors are hiding on the server?

What about the crucial elements that a person cannot detect?

A human cannot look inside the file at the details. Only by analyzing each file with automated systems designed to do so, can you detect the kinds of problems that occur in file-based video. These can include:

- Incorrect play time — measured with frame accuracy.
- Putting the audio on the correct channels (or omitted altogether).
- The wrong format of the content has been provided.
- Incorrect stream setup (e.g. three seconds of audio silence is required at the start but is not present).
- Compliance to various industry de-facto standards. The stream is correct and legal, but still not what the client needs (e.g. H.264 instead of MPEG2).
- Missing required data for closed captioning.
- Transport Stream and multiplexing errors.
- Missing metadata used by an automation system.
- Incorrect bit rate for the video or audio.
- Encoding quality errors, where the encoder produces a series of blocky video frames.
- MPEG encoding syntax errors, which can occur due to multiple mux/de-mux operations, or an encoder/transcoder blip.
- Errors in the syntax of the video and audio elementary streams.

Any one of these items could catastrophically impact the quality of what the viewer sees and hears — or doesn t see and hear.

Of course, there are areas to check for which humans are essential - checking for inappropriate content, as an example. However, if all the technical aspects are good, this checking can almost invariably be done either on a quick sample basis (is it really this movie) or a very fast 10x speed scan through to quickly find any scenes which might require further attention.

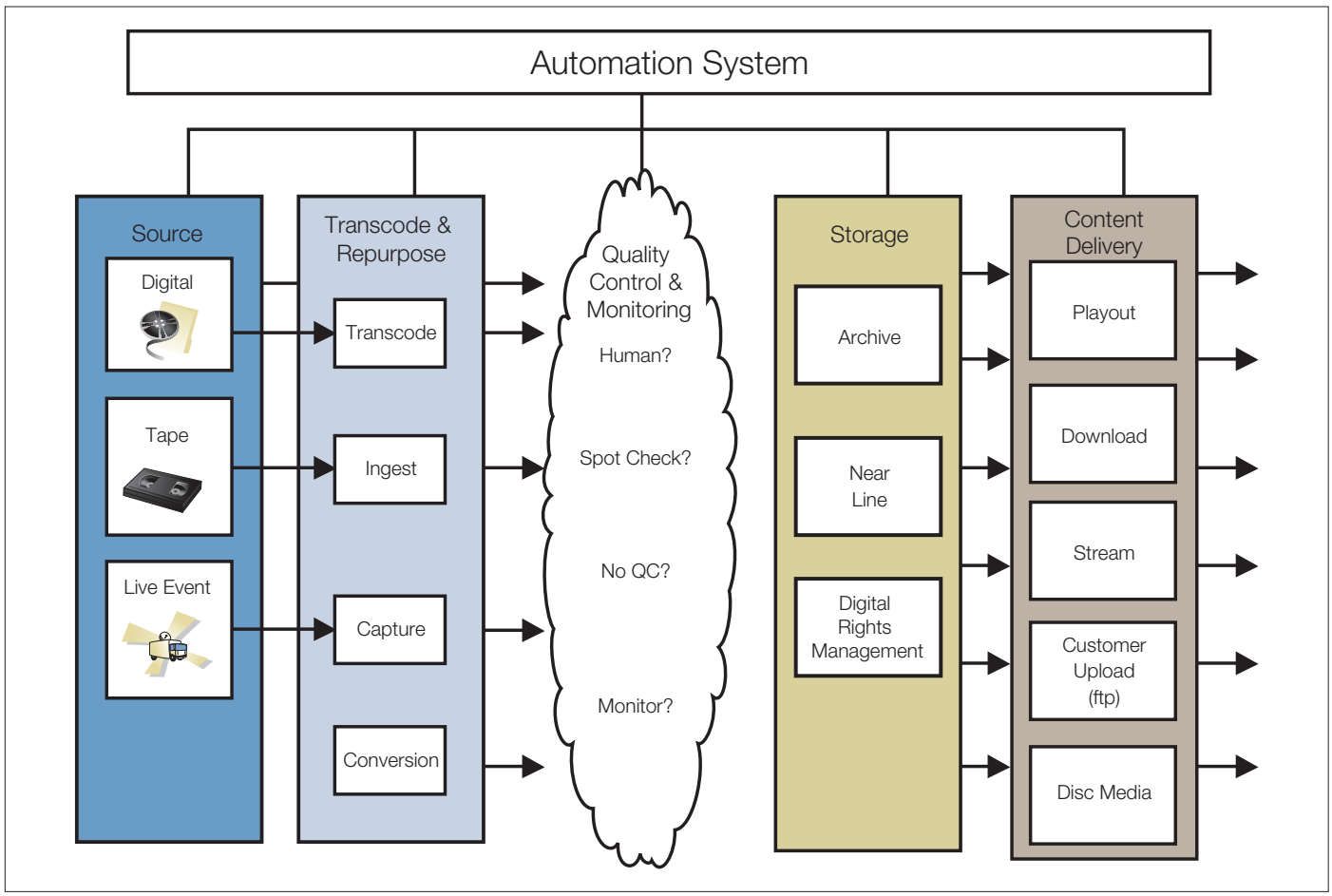


Figure 1. Content Interchange Workflow.

How will you manage the transition to digital with lots of new formats?

As broadcasters, content services providers and content aggregators exchange more and more content, Content Interchange workflows have emerged. There are a variety of QC approaches, depending on the workflow. What sufficed for QC in a tape-based workflow (i.e. simply viewing the tape) will not be enough in a file-based workflow.

Even the simple act of viewing a compressed file requires decoding. After decoding to baseband, whether or not problems are detected, whether any amount of external correction may have been applied; the audio and video must be re-encoded. There is a great chance that this process will introduce errors:

- The file must be recompressed to the same video standard MPEG-2, MPEG-4/AVC, VC-1, etc. Alternately, any transcoding must be done with care.
- It must keep the same parameters, which are sometimes set manually over a range of frames to get the optimum appearance.
- Software-based transcoders may introduce freeze frames or skipped frames to meet strict bitrate budgets.
- The compressed video will need to be re-multiplexed with the correct audio and metadata.
- The metadata might need to be updated to reflect any changes or editing that occurred.

The point is that as facilities rely more on file-based video sources, it becomes even more important to be sure that what is stored will be useable when it comes time for playback. Figure 1 shows a Content Interchange workflow. Let s examine how three different companies exchange content, and their typical approach to QC today without automated verification.

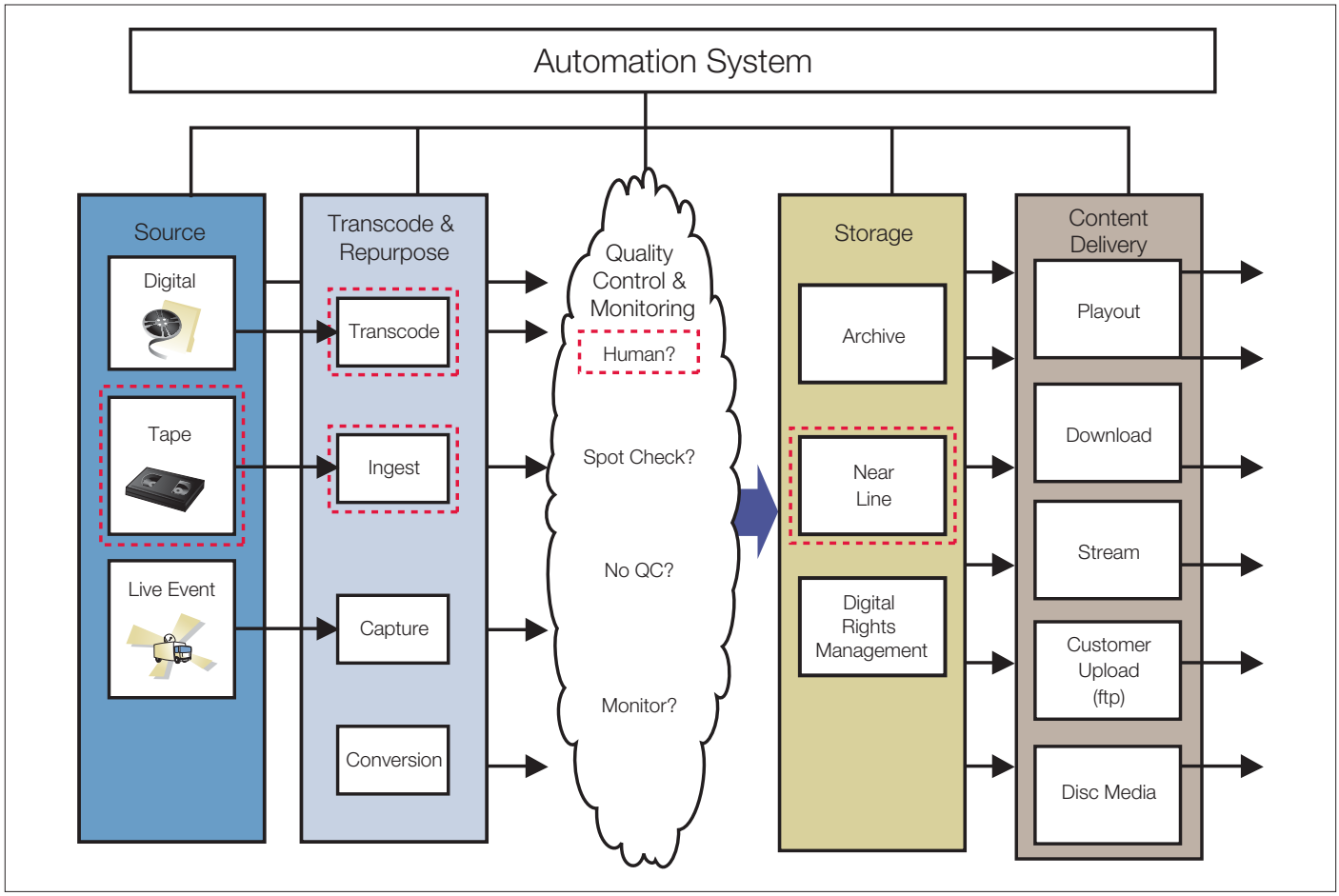


Figure 2. Content Services - Content Interchange Workflow.

Content Services - Mezzanine Ingest

Video at a Content Service Provider may follow two or more paths through the steps the workflow.

In the example in Figure 2, the input source might be a **Tape**. It passes through **Ingest** and a mezzanine level (high bit rate digital master like 50 M/bps MPEG-2) is created. Next, the file is **Transcoded** to an end services platform (format) for a client. There might have been visual inspection at the initial ingest process, which is often watching for tape hits on the encode process, but the visual inspection does not show what the encoder is doing. Is the tape being captured correctly? Has the encoder been correctly configured for the tape format? Regardless, the file is placed into **Nearline Storage.**

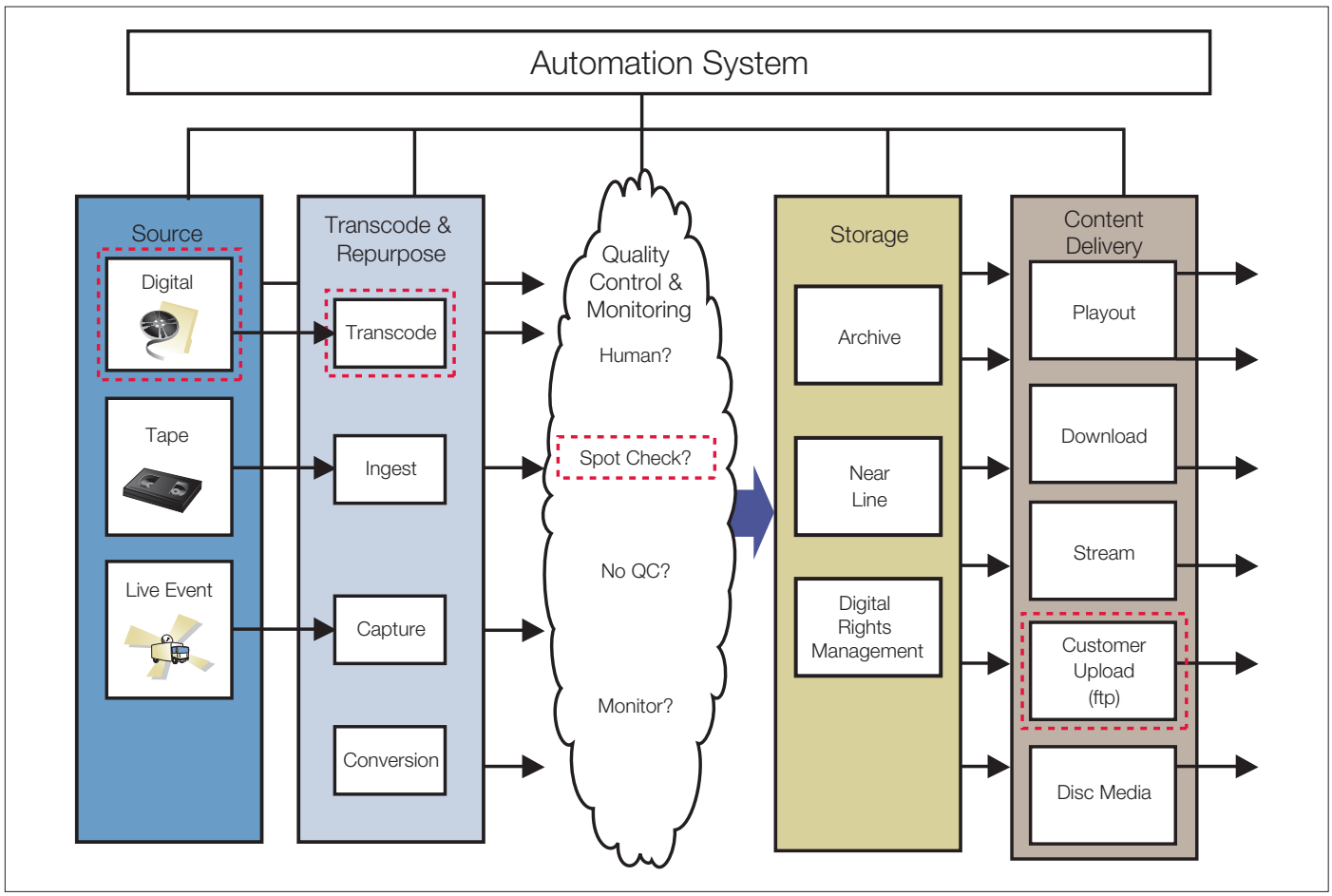


Figure 3. Content Services - Content Interchange Workflow.

In a second path, shown in Figure 3 the input source might be a **Digital File**. The file is **Transcoded**, and visual inspection is a spot check of tops and tails (the beginning and the end). The file is **Uploaded** by FTP to the client.

The growth in content volume leads to transcoding more and more files. This change in transcoding volume has a direct impact on the QC strategy. Do you have time to QC everything at each step?

A basic assumption is that when ingesting the original tape, there was 100% QC (via visual inspection) and you caught all the errors. If you don t catch the errors, the errors will be in all of the transcodes. Then it s up to the spot check to catch these errors. This can be an expensive process if you catch the errors at the end - it may be too late to re-ingest the original source. 100% QC at initial ingest is necessary to prevent the ripple of faulty content downstream. By the time that you get to the repurposing process, the only errors should be the ones introduced by the transcode process.

Being forced to repeat the digital mastering process is often referred to as churn , and it truly is the cost of failure. Going through this process once, taking a tape to digital file, could include a standards conversion, adding letterboxing, and adding close captioning. Depending upon the cost and time pressure of having the correct file, the number of times that the digital mastering process is repeated could make the difference between making and losing money.

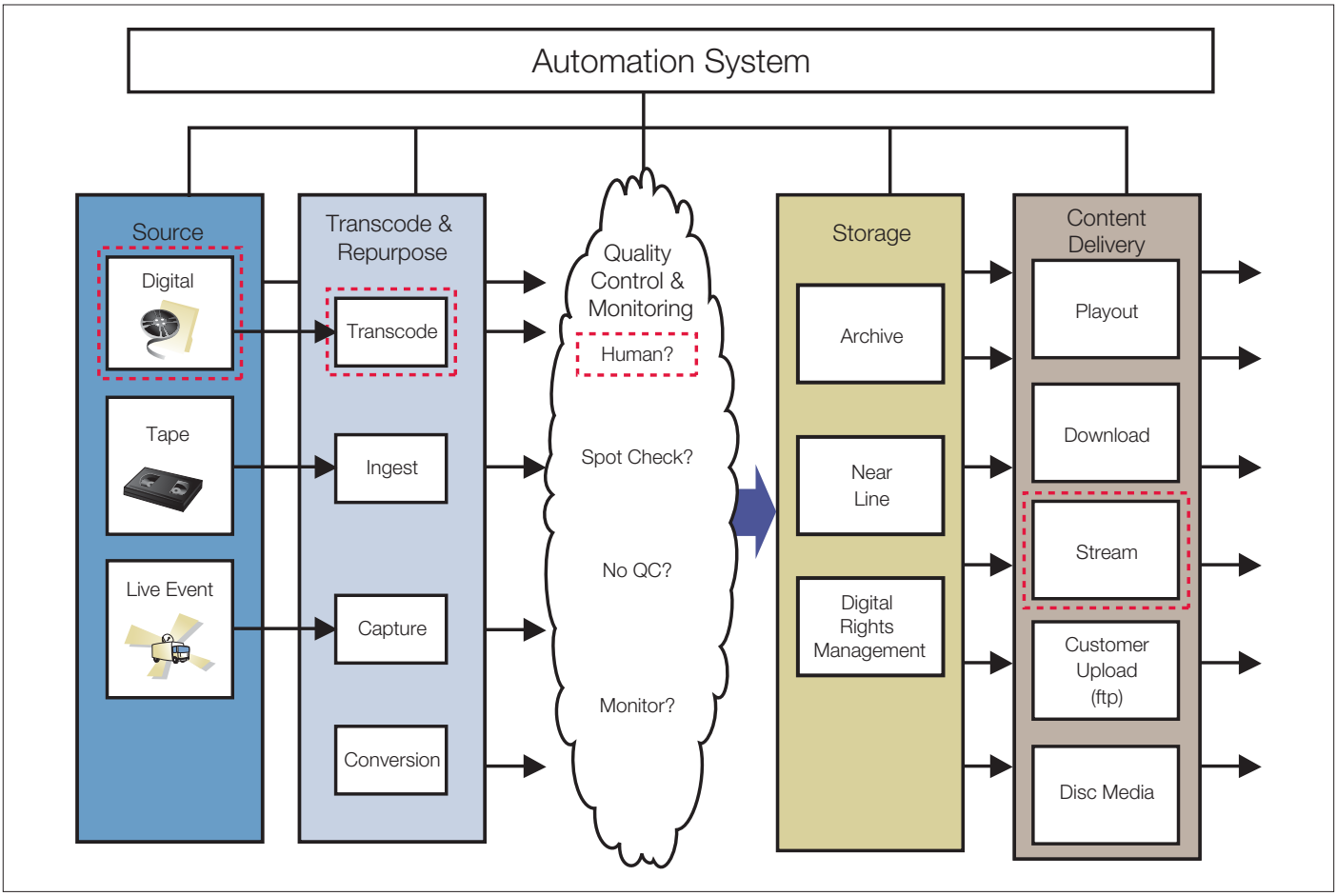


Figure 4. Content Aggregator — Content Interchange Workflow.

Content Aggregator – Multiple Transcodes and Streaming

In the example show in Figure 4, the **Source** is a **Digital file** (perhaps transferred in by FTP), it is **Transcoded**, possibly including a standards conversion (e.g from HD to SD), the QC is 100% visual inspection and file might go through the QC-back-to-transcode loop several times in order to achieve the required quality. This is because running at such low bit rates, transcodes often don t work perfectly the first time, and especially on fast action sequences. When it looks good enough visually, it moves to the last step of **Content Delivery** in this case a **Stream** for playout.

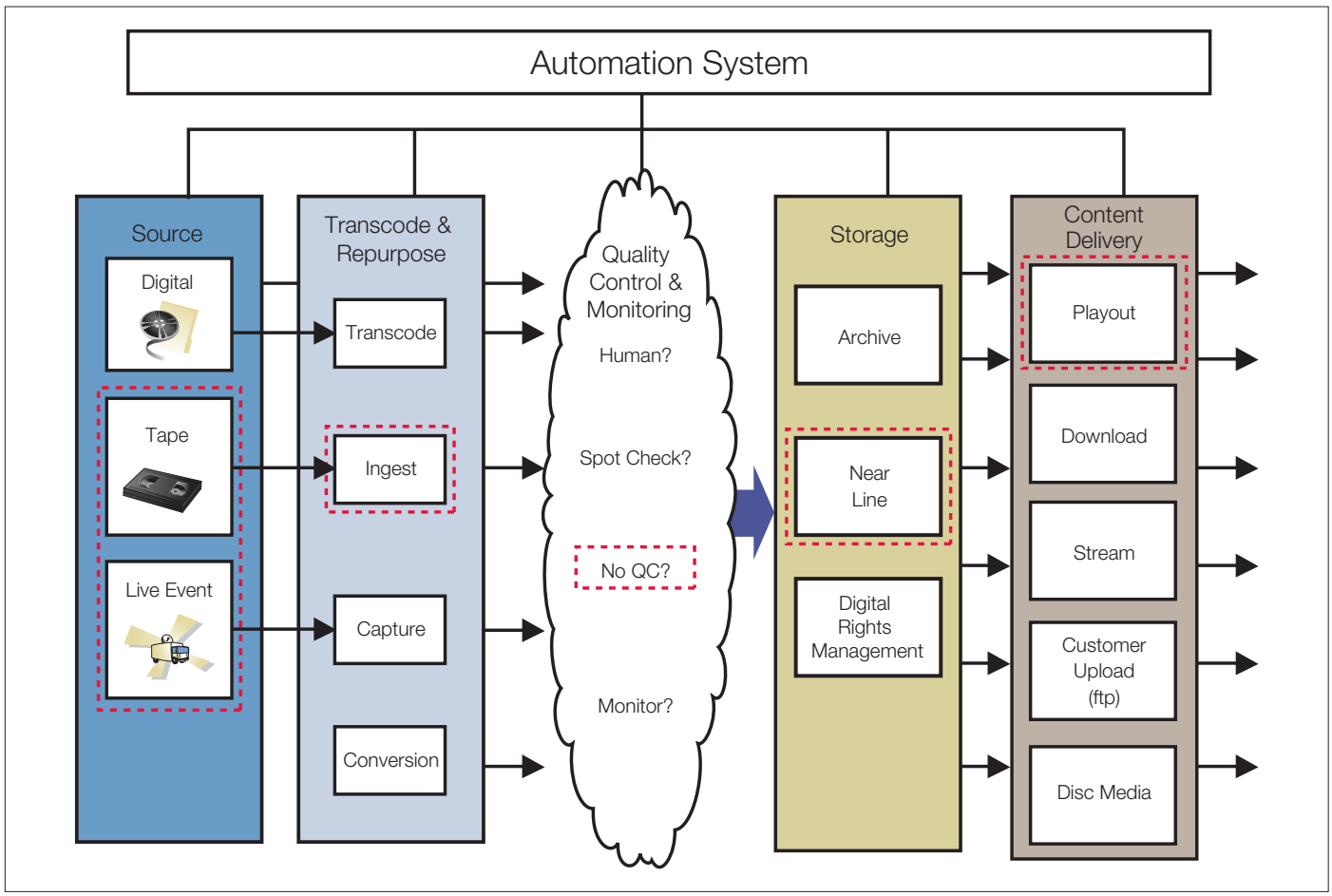


Figure 5. Broadcaster — Content Interchange Workflow.

Broadcaster – Multiple File Movements

In Figure 5, the source is a **Tape** or **Live Event**, which is **Ingested** to a mezzanine format (like MXF MPEG-2). Clearly the biggest challenge is the ingest process. There is typically no human QC. Having to go through the ingest process again on a live event may be impossible. Having a QC strategy that tells you that you either got it right the first time, or what exactly needs to be addressed, is critical. Lastly the file is sent to **Near Line** storage and from there to **Playout**. Often, the file is moved from Near Line or the air server back to archive if it is not to be used again within a certain time frame.

In all these examples, doing only visual QC, and just once during the processes, leaves the door open to costly rework or make-goods downstream.

How will you manage the expansion of your business and maintain your reputation for quality?

Broadcast Operations are reaching critical mass. The volume of video is multiplying as business units continue to re-format and re-purpose video for new revenue streams. Some broadcasters say they are exponentially growing content while only linearly growing QC. But faced with a large growth in channels and services, scaling your QC strategy with the increase in content volume can become difficult. Some potential strategies are:

- Scale down from full QC of all material to perhaps viewing the beginning, middle and end of programs or spot checks.
- Check one program out of ten (sampling).
- Leave the checking to the next consumer.

How do you monitor the quality of many new channels when there are different formats and quality levels required for terrestrial, satellite, cable, VoD, and IPTV? Once you decode and re-encode to a different format, how do you make sure that the quality remains intact? Have you found a way to check each different version required for SD/HD, for internal archives, third party licensees, and international frame rate versions? There are a variety of other factors that have an impact on your brand quality as you expand your business. Here are some examples of real world challenges:

Repurposing - A music channel is straining to fully check only its high bit-rate encoding of incoming master (mezzanine) files, but has not yet found a way to check each different version required for their internal archives, third party licensees, several international versions, VoD, etc.

Time - Sometimes, there is just not enough time. A major late-night talk show must be edited and reformatted to be on syndication servers and third party platforms by the very early morning. Even if you can still use people for checking video, you may not be able to hire the right talent at the right time of day.

Another very popular network show is anticipated by its viewers each week. However, for reasons of security, the program is not given to the network until two hours before airing. Again, this must be repurposed to their website and other VoD networks within 12 hours.

Scalability - Broadcasters are both centralizing equipment and decentralizing QC. This means, that they want all QC hardware centralized to control costs, but wish to decentralize the place where the work can be done. This frees up expensive real-estate and allows more freedom in contracting out QC. Content Services companies have work groups all over the world — decentralizing is the key.

Automation System Integration - Automation systems are constantly improving their ability to track and move files from ingest to playout. QC workflow integration with asset management systems will help leverage your investment and facilitate scaling — while maintaining consistent quality levels.

Interoperability - How do you make sure that all of the encoding and mastering equipment in your company all have the same configuration? There is always a need to monitor equipment configurations like the settings on encoders and decoders.

Establishing a new content vendor - It may take months to get the digital mastering correct for a new VoD system or web platform. How do you test your content before it is rejected while on-line?

Who would you rather do business with? Someone who guarantees files meet a specification or someone who requires you to test each one yourself?

Due to the amount of new and repurposed content, Content Interchange continues to accelerate. Communicating and documenting your requirements for file content requirements between content providers and content users can be difficult.

You may already embrace the concept of a Content Conformance Agreement (CCA), but you may call it by another name. Chances are that you don t have it written down anywhere — just a verbal agreement. You may have several; one for each client. Unless you have an automated system, how do you enforce this? It is not possible to enforce a subjective agreement — especially if there are elements in an agreement that will be missed in visual inspection. It has to be non-subjective. You have to be able to reject it and push it back if there is ever a disagreement.

Category	CCA Parameter
Video Standard	MPEG-2
Profile & Level	Main
Play Time	Greater than 60 min
Horizontal & Vertical Resolution	720/480
Frame Rate	29.97 fps
Bit Rate	3 – 3.5 Mbps
Display/Aspect Ratio	4:3
Color Depth	4:2:0
Black frames at start, end or during video	Min 2s black at start; Min 2s black at end
Letterbox and Pillarbox checks	Disallowed
Blockiness	Not greater than 75%
Luma Limit Violation	None

Table 1. CCA for a feature-length movie for full format VoD.

Ideally, checking the file against an agreed upon CCA would allow you to have an automated content filter to evaluate your incoming content. Table One gives an example of the content parameters in a CCA for correct file configuration and quality of a feature-length movie for full format VoD.

Using a CCA could make the difference between content being accepted or rejected both upstream and downstream.

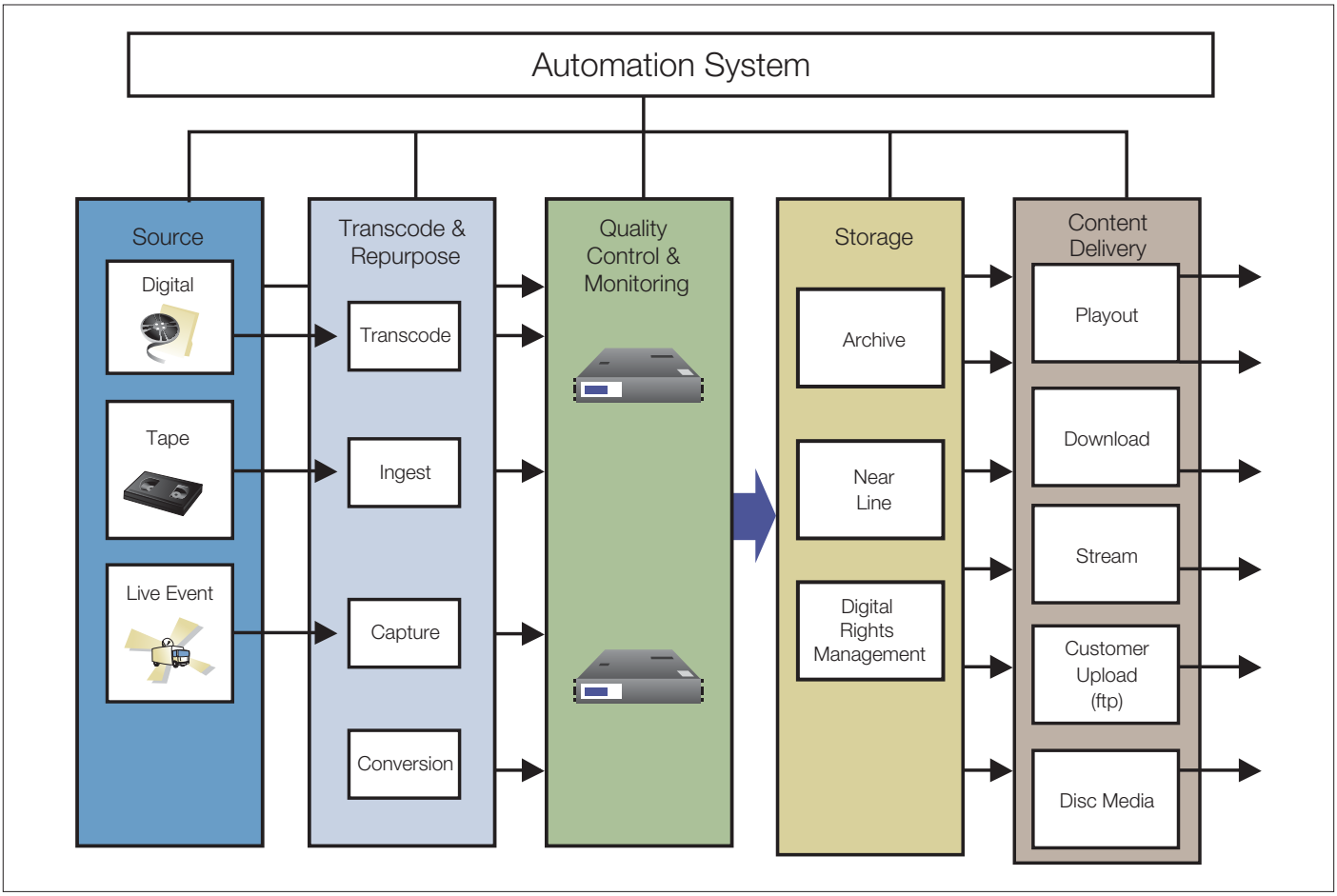


Figure 6. Content Workflow with automated testing at multiple stages.

The Solution: Tektronix Cerify®

The industry choice for automated Quality Control of file-based video.

The Tektronix Cerify is a fully automated system for verifying and checking file based content. Cerify is integrated into a network, and automatically checks the correctness of file-based content against defined standards, at many stages.

The multiple levels of testing mean your content:

- **Will play:** it is syntactically correct and correctly encoded
- **Can be transmitted:** the transmission parameters are correct
- **Is technically legal:** gamut, audio range etc. are within limits
- **Is structured correctly:** audio on the right channels, correct length, etc.
- **Quality is good:** video is not blocky, audio is not clipped

A summary the operational benefits of Cerify is listed in Table 2.

Operations Challenge	Cerify Attribute	Cerify Operations Benefit
Verifying impairments that QC staff can't see. Insuring repeatability in the content QC process. Content has security considerations. Content has short turn around time before playout.	Automated file verification with syntax checking	Now you have an insurance policy against 'dead' air time. Cerify works unattended 24/7 to perform over 800 tests on all the invisible aspects of compressed video/audio files. Automated QC allows you to make your QC staff more efficient by having them concentrate on the 5% of the "bad" files, rather than spending their time watching the 95% of "good" files.
Verifying that the content meets the requirements for correct file configuration and quality.	Content filter templates	Establishing a Content Conformance Agreement that is service content specific reduces rejected content and churn rate. Consistently audit the performance of your content suppliers.
Insuring that all of the encoding and mastering equipment has the same configuration.	Content filter templates	A content filter makes it easy to monitor the interoperability of equipment configurations like settings on encoders and decoders.
Will automated QC integrate with my existing automation system and server network?	System Integration	Cerify speaks to existing automation systems via Ceri-Talk™. This allows the automation system to automatically control processing of files by Cerify. The Cerify Developer Community insures that Cerify can have a seamless QC workflow between major server, encoder and automation system manufacturers.
Reducing churn rate – determining why the content was rejected.	Audit trail	Cerify logs error detail as the content is checked. Diagnose and troubleshoot errors down to the frame level.
Scaling the QC staff.	Scalability	Start with one Cerify unit and analyze up to 4 files in 2X real time. Grow your system by clustering three or more Cerify units to match the required throughput and still allow for future growth.
I need to centralize my digital mastering and decentralize my QC.	Accessibility	The Cerify GUI is web-based so multiple users at the same site, or at different sites, can access the testing and results using a standard web browser.

Table 2. Operational benefits of Tektronix Cerify.

Conclusion

While the interchange of content continues to grow exponentially, visually inspecting program content fails to identify costly problems. In fact, visual inspection of incoming file-based video content as a means of Quality Control is not comprehensive, fast or scalable.

Server based, automated file verification provides a content filter that can catch the errors that people would normally miss, and gives you a way to uniformly check the conformance of the content that you accept. A specific content filter, with your unique program requirements can be used to establish a Content Conformance Agreement (CCA) with content suppliers and customers. Documented CCA results can reduce rejected content, create an audit trail, and increase the quality of content viewed by the consumer.

Workflow integration is not painful. You do not need that change everything that you do. Using automated file-based QC solutions can reduce your end-to-end file time, reduce the number of people in the workflow, and reduce churn by having your content accepted the first time.

Automated Quality Control can scale with content growth, increase service quality, and get better leverage out of existing QC staff.

Call a Cerify Systems Specialist today to find out how fast Cerify can pay back your investment. Call your local account manager or e-mail james.page@tektronix.com

For Further Reading:
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For Further Information

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