Q3 2013

QUALITY CONTROL FOR FILE-BASED CONTENT AT YLE

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ABSTRACT

With the introduction of file-based video, the importance of the technical quality control (QC) of the video essence becomes higher than in the video tape domain. The combination of modern video tape and a well maintained VTR is considered to be a very reliable way of storing and delivering video signals from one location to another.

Video files introduce different challenges to those of video tapes. While transferring video from the production facility or content owner to a broadcast facility, the video files are transferred typically through several stages including network equipment, mass storage devices and server computers. Also, one or more format conversions may be applied during the processing of the video file.

Furthermore, in addition to the video and audio data, the container that is used to store the content essence needs to be error-free; and since there is no internal error correction in video files and the devices used to play them back, one must take extra care of the integrity of the video files.

This article explains the current state of video file quality control at the Finnish Broadcasting Company (Yle).

DEFINITION OF QUALITY CONTROL FOR YLE

Technical quality control (QC) can have different meanings and interpretations in different contexts. One person may understand QC as a task carried out by a human operator to control how audio sounds and what video looks like in a programme. Someone else may refer to it as an automated procedure that is used to locate technical data errors in a video file. In a broadcasting company, QC most probably covers both of these and more – and this is the case at Yle.

QC at Yle can be divided into four separate categories according to the workflow in question: programme production; programme acquisition; play-out; or archive migration. The following sections describe the characteristics of these four types of QC.

In general, QC activities at Yle try to ensure that play-out automation can play back a video file, that the technical quality of the video and audio are acceptable, and that there are no issues that have not been detected by the automated QC.

Yle has four years' experience of automated QC. We use Tektronix Cerify and Interra Baton to QC content that arrives as video files; and Cerify is used to QC the results of video tape digitization.

QC IN PROGRAMME PRODUCTION

There is no automated QC in Yle's own programme production at the moment. The quality of audio and video in programme production is assessed by qualified technical staff, like sound engineers and editors, during the production process. These people have been trained to produce high-quality signals, and taking a certain professional pride in their work, they maintain good production quality.

Due to the recent publication of loudness related regulations [1], Yle is currently setting up a project that introduces suitable metering tools and practices to ensure that the audio signal resulting from our own programme production process meets the requirements of the EBU R 128 recommendation. All relevant production units should be equipped with new audio meters before end of this year.

The technical quality of in-house productions is consistent and there are usually no major quality issues. However, it can happen that a camera shoots video with incorrect video field order, and the problem may not be detected during the production process, but noted only while actually broadcasting the programme.

QC IN PROGRAMME ACQUISITION

Every year Yle purchases some 5,500 hours of content from international content-owning companies and independent production houses. In 2012, 3,600 hours of this content arrived in the form of video files while the remaining 1,900 hours came on video tape.

Figure 1 below gives a basic overview of the current process for content bought from external sources.

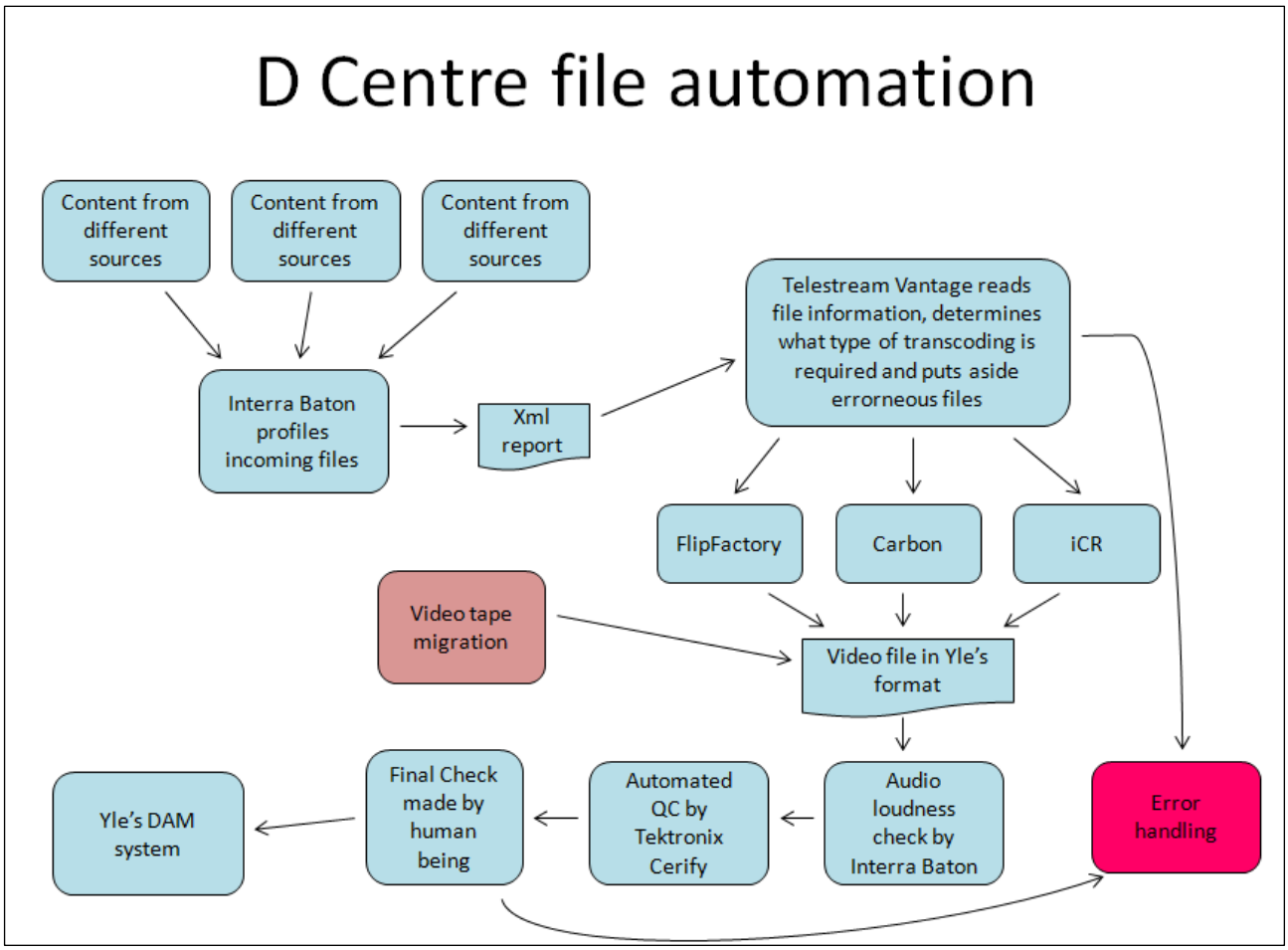

Figure 1: D Centre file automation

All incoming content is first profiled using Interra Baton. This enables us to know when and in which format a file has arrived for processing.

After profiling has been completed, Telestream Vantage takes over the control for processing the file. It applies some basic checks - e.g. it finds out if there are both video and audio tracks in the file, and if the file wrapper and source codec are acceptable. If Vantage finds errors, it moves the file to an error handling routine and sends an alarm to the operator by e-mail. This enables us not to use up transcoding and QC capacity with files that have obvious problems.

If a file is found to be good enough so far, the next step is to transcode it to an in-house video file format - MXF wrapped DVCPro50 for SD, and MXF wrapped XDCAM HD422 for HD. We use several transcoding applications because we find a single tool does not process all types of content well. For example, standards conversion between NTSC and PAL seems to give bad results with some transcoding tools.

After a file has been transcoded, it is forwarded to Interra Baton which applies the EBU R 128 based loudness check to the stereo (or possibly 5.1) audio within a file. At the moment, audio loudness adjustment needs some occasional compromises, because the play-out currently works with previous generation recommendations where only the -6 dBFS peak level of audio is taken into consideration. With the new loudness recommendation, an audio programme can comply with EBU R 128 and violate the old recommendations at the same time.

Next, automated QC is applied to all transcoded files using Tektronix Cerify which checks the technical quality of the file structure and essence. The QC for SD and HD files uses slightly different parameters because their file formats are different.

After automated QC has ended, the in-house developed software “Trolli” is used to bring all relevant information about the file, including loudness analysis results and automated QC results,

to the user interface of an operator, who makes a so-called final check on the file. During this final check, the operator views QC results and plays back the beginning and end of the video file, as well as random points in the middle, using the same version of video server that the play-out automation system uses. Using the same type of video server on these points goes some way towards guaranteeing the quality of the checked files before being played back at broadcast time. There are insufficient human resources to play back whole programmes, even though this would allow us to find some errors that are not identified by automated QC and random play back. Luckily, the number of errors that are not detected before broadcasting is relatively low.

If the operator finds the quality of a video file acceptable, the file is fed into the Digital Asset Management (DAM) system for later broadcasting. If the quality was not acceptable, the file will be put into error process, which means that the operator writes a report on the error and returns the information to one of Yle's material coordinators. The coordinator then communicates the error to the party who provided the content. In some cases of minor errors, Yle staff correct the files themselves.

In certain situations, our staff uses both Cerify and Baton to analyse the file in order to see if the one tool finds something the other did not.

Some of the errors and faults in the MXF structure are not always detected by Cerify or Baton. In these cases, we use IRT's MXF Analyser Pro to analyze the structure of the MXF file, including the content of the header metadata for each partition. In our experience this is a very useful tool for detecting errors in MXF structures.

In summary, the QC is not accomplished by just one piece of software, but it is combination of quick checks by Vantage, loudness analysis with Baton, full video and audio automated QC by Cerify, and final checks made by human operators using the same type of video server that is used to broadcast the content.

QC IN ARCHIVE MIGRATION

Table 1 shows the totals of different types of video tape in Yle's television archive, and the status of the digitization work in autumn 2012.

Tape format	# of tapes	# of digitized tapes
2 inch tape	11,000	0
1 inch tape	54,000	10,800
Betacam SP	156,000	15,700
Digital Betacam	174,000	44,300
D3	12,000	5,700
DVCam	54,000	6,100
DVCPro50	684	540
DVCPro25	3,300	610
HDCam and HDCam SR	1,700	200

Table 1: current progress of digitization work

The tape digitization format is DVCPro50 in MXF Op1a container for SD material and XDCAM HD422 in MXF Op1a container for HD material. All Yle tapes should be digitally ingested by the end of 2020.

The tape digitization process is divided into two stages, and first phase of the process is called tape preparation. During this preparation phase, all the tapes are cleaned, and the video and sound levels are checked and adjusted. The video and sound levels for each tape, as well as other

preparation-related metadata, are stored in the in-house automation system, Trolli. Trolli automation controls the video and sound levels during the actual digitization process, which takes place later on.

The second phase is the digitization and final check. All tapes are digitized using VTRs within flexicarts, or standalone VTRs. All flexicarts and VTRs are controlled by the Trolli automation system. During the actual digitization process, Tektronix Rasterizer detects all audio and video values and limitations which have been set up on the machine previously. The VTR also notifies Trolli automation about video head clogs (which produce high bit error rates). Automated file-based QC is done using Cerify after the tape is digitized. During the final check, the operator plays back the beginning, middle and end of the file with same type of Omneon server that is used in the continuity centre. The operator checks Rasterizer and QC reports, and if the quality of the video file is acceptable, the file is archived in the DAM system by the Trolli automation.

QC IN PLAY-OUT

Three days before a programme is scheduled to be broadcast, the play-out automation system in the continuity centre starts to fetch video files from the DAM system. At this point of time, there is no longer any automated QC, but the staff of the department responsible for broadcast operations again plays back the beginning, middle and end of all files to ensure that the files can be played back satisfactorily. However, not all issues may still be detected. It happens every now and then that a part of the content that was not played back during the earlier final check before broadcasting, contains an error that gets revealed only during the broadcast.

In theory, a faulty network or the storage equipment used during file transfers may corrupt a file, and then the corrupted file can cause problems for a video server and even make it crash. The time needed to recover from this type of situation may be long; thus, a means of verifying file integrity between final check and broadcasting should be implemented.

HOW TO SET UP CORRECT PARAMETERS FOR AUTOMATED QC

Over the past four years, we have found that it is quite challenging to set up all the right parameters for automated file-based QC. When Yle started automated QC, we took recommendations from vendors, and slightly modified the values after using Cerify for some time. Now we are in the middle of the process of re-evaluating our current QC parameter set.

It is possible to apply a large number of different checks to the content. Ideally, one should find all file structure errors and baseband quality errors which might cause defects during later broadcasting or production. On the other hand, if the prescribed values for some check parameters are too tight, excessive errors are returned, and one can easily lose other relevant and important information while checking the QC results. Seeing too many meaningless errors can cause an operator to become de-sensitized and ignore also the important ones. Thus, all checks and their parameters should be designed to be suitable for the type of material being checked, and all errors detected should be meaningful.

After seeing the errors produced by the QC tool and viewing the appropriate location from the file in question, the operator should be able to decide if the problem should be ignored, be corrected, or the content and error description be returned to the party that sent it. Also, the error descriptions should be very clear and precise to allow different parties to understand what the error really means.

When starting to use automated QC, one should select a basic set of checks and define suitably considered values for these checks. After applying QC to some of the material, one should check the QC results and determine if the parameters need to be adjusted in order to get more accurate results, or conversely to reduce the number of non-meaningful errors.

The following parameters are checked as part of Yle's QC: MXF container structure; MPEG-2/DV compliance; picture size; display aspect ratio; colour format; field order; black frames; freeze

frames; blockiness; luma levels; RGB levels; audio standard; PCM specification; number of audio channels; audio sample rate; silence; peak levels; clipping; loudness according to EBU R 128.

DIFFERENT TYPES OF ERROR

Some errors are rare, while others occur more often. According to Yle's experience the most common errors are the following:

- Audio level problems; e.g. audio loudness level, or traditional peak level, is too low or too high.
- Audio channel order is incorrect; this error cannot be detected using present automated QC tools.
- RGB level violations.
- Field order problems; some of the camera shots or credits at the end of programme have field order errors - this problem occurs more often in SD programmes.
- Blockiness; as seen in Figure 2 below.

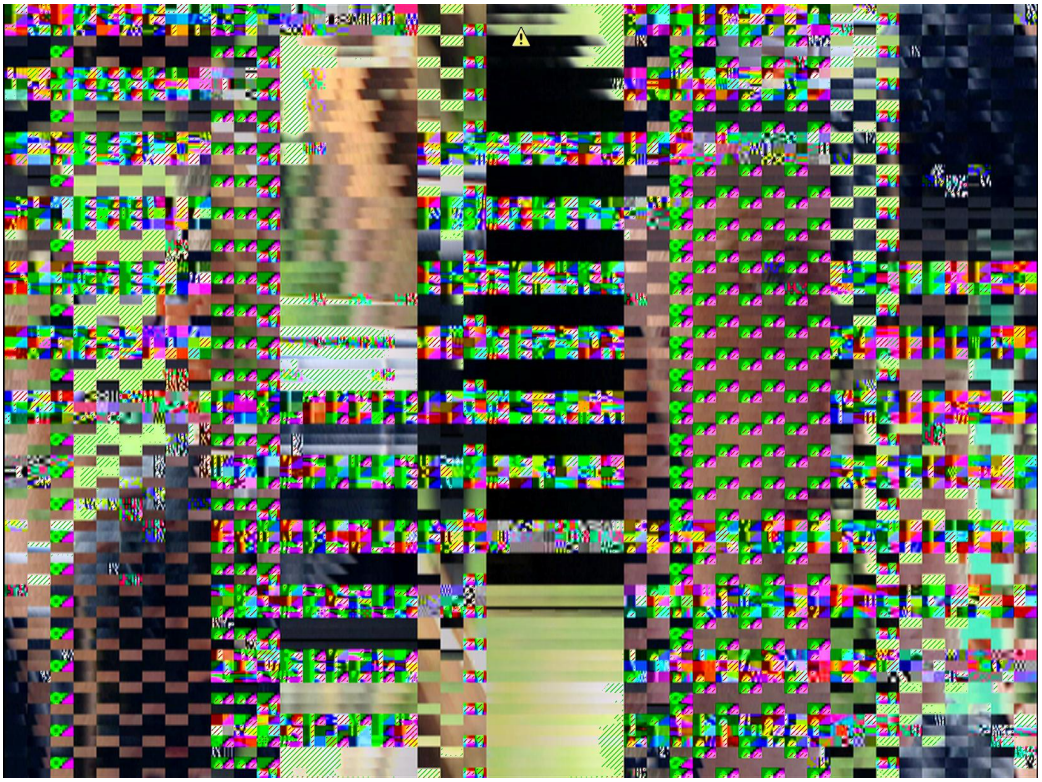

Figure 2: screenshot of video with macroblocking problems

In addition to the real errors and "false errors", there are lots of different issues which automated QC cannot find: audio and video out of sync; double frames generated during bad 24p to 50i conversion; extra frames resulting from careless editing; incomplete programmes; incorrect audio track order; audio track swap in the middle of a programme; wrong language; and poor technical quality - which can be a very subjective thing to measure.

Some of the identified errors can also be "false positives"; e.g. a detected field order problem might not be a real field order issue, but something else in the image that causes a QC tool mistakenly to report a field order error, like waves on the surface of a lake or a flag waving in the wind.

For these reasons, some human QC is an absolute necessity; and as stated before, all checked files are played back and reviewed at the beginning, middle and end, using the same version of video server that is used in Yle's continuity centre.

THOUGHTS ON THE CURRENT SITUATION

Yle's QC operation is quite effective. Even though problems are detected occasionally, our process can catch most of the errors in the audio and video files. However, at the moment, we still need to learn more about the best way to run automated QC and how to set up the optimal parameter values.

Once a problem is found, it is important to have up-to-date instructions for error recovery in order to allow operators to take appropriate action to correct or go around the problem during the QC process or the pre play-out check.

The advantage of international standardization is obvious - having sophisticated automated QC tools with a well defined set of checks available can notably ease the life of every broadcaster. Luckily, the EBU is already working on such a future standard [2].

Yle has decided always to keep the original files received from external partners as a backup, and this has proven to be a good decision. Should an error occur, we can go back and see if the error was already in the original file or if it was introduced while processing the file internally.

FUTURE PLANS

Yle's QC environment is not yet fully operational, and we need to do further development work to make it more sophisticated. First of all, we need to understand how QC parameters and their values set up a few years ago should be set today. Some values can be set in quite a straightforward way, but others need more consideration because there can be many "false errors".

The automated QC tools that are employed now should be benchmarked against the latest commercial products in the marketplace in order to find out if they can perform automated QC better or faster.

The company's internal production chain should be analyzed to see if automated QC could provide additional benefits - e.g. locate camera shots with incorrect field order.

The automated and manual QC processes should be integrated into self-healing workflows where possible - e.g. re-mapping audio channels or applying automated loudness correction to video files.

We believe that a checksum based automated integrity review of files between final check and broadcasting could save human labour in the future – but even more important is that the checksum verification could reveal errors that are difficult to detect using other means, e.g. errors created by faulty equipment. A malfunctioning network switch or defective hard disk storage can randomly corrupt video files. This was the case in fact at Yle few years back, when a problematic hard disk storage unit started to randomly corrupt data blocks in just four percent of the files stored on the device. The root cause of problem was extremely difficult to find.

While introducing workflow automation for video file processing, our environment has become more complex. Some components or their versions will change in the future; thus, we need to set up solid test routines to prove the transcoding and QC chain every time a component changes.

Last but not least, we need to improve reporting and documenting of identified problems in order to better communicate with the different interest groups.

CONCLUSIONS

File-based content production, archiving and play-out are developing fast. Also automated QC tools are constantly developing and becoming more comprehensive. The best tools can definitely assist a human operator with the task of ensuring good technical quality; but automated tools

cannot detect all issues and there is still a strong need for the human ear, eye and brain to verify if something is an error or not.

After detecting an error in a video file, one needs to communicate the error to different interest groups. This sets the demand for standardized vocabulary and terminology. An international standard for automated QC can simplify this task by providing standard terminology and means for documenting errors. In addition to this, one needs to prepare content purchasing agreements well, and agree precisely the file formats to be used at the time of content delivery from content owner to broadcast company.

Technical quality issues, especially those relating to loudness, are not always obvious for small independent production houses. For this reason, it makes sense for broadcasters to disseminate relevant knowledge to their partner company network. For example, Yle has decided to allocate effort to educate domestic production houses with regards to the implementation of the EBU R 128 loudness recommendation.

Capabilities of different tools vary, and at least we at Yle believe that it is good practice to have tools from a number of different vendors at one's disposal to detect diverse issues from video files.

Managing the integrity of audio and video is very important in the domain of file-based content. By managing integrity and quality together, one can avoid unnecessary work relating to the checking of content during the different stages of the production and distribution chains. At the end of the day, it is all about workflows - and therefore, workflows should be planned and well managed.

REFERENCES

[1] European Broadcasting Union: Recommendation R 128 – Loudness normalisation and permitted maximum level of audio signals, August 2011

[2] EBU Strategic Programme on Quality Control http://tech.ebu.ch/qc

NOTE

All product names mentioned in this article are the registered trademarks of the companies mentioned in each case: Tektronix, Interra, Telestream, IRT and Omneon.

AUTHOR BIOGRAPHIES

JOUNI FRILANDER

Jouni Frilander studied computer science at the Commercial Institute of Helsinki and graduated In 1994. He has developed and managed broadcast related IT systems since the early 1990's. These systems have included metadata management, information retrieval, digital sound archives, computer aided radio systems, DAM systems for video, audio and still images, video file workflow automation systems and automated video file QC systems.

He has worked in various career roles including System Analyst, Systems Manager and Development Manager. Currently he works as Technology Advisor for the Finnish Broadcasting Company's Platforms, Operations unit. Jouni is member of the Technical Committee of International Association of Sound and Audiovisual Archives.

ILKKA TUOMELA

Ilkka Tuomela, was born 1975, and joined Yle in the year 2000 as a trainee, after graduating from Media School. After several months training he worked for some years as a sound engineer in Yle's Radio Division, and later on as an editor in Production. He now works as Media Manager for Yle.

Ilkka has many years of experience in file-based production, delivery and transmission systems. He is really keen on preserving high video and sound quality for broadcasting and archiving purposes. He has been working as Media Manager since 2008 in the Archives, Research, Media Management and Information Services department of Yle, where his main responsibilities are transcoding and quality control tools, while also focusing on developing file-based workflow automation.

Published by the European Broadcasting Union, Geneva, Switzerland

ISSN: 1609-1469

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