The automated file-based QC system at NRK

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Between 2007 and 2009, NRK carried out a project called the "Programme Bank", the main goal being to transform its TV production infrastructure to a fully file-based platform with an incorporated MAM system. Today, the Norwegian broadcaster is running an Interra Systems Baton Enterprise Edition (Windows) system with 28 core licences for its automated file-based QC system.

This article describes the background to the project, the technical details of the Baton system that has been installed, along with NRK's experiences with the system during the setup and initial phases.

An overview of NRK's infrastructure for television is shown in *Fig. 1*. The main goal of the "Programme Bank" project was to transform the TV production infrastructure to a fully file-based platform with an incorporated MAM system.

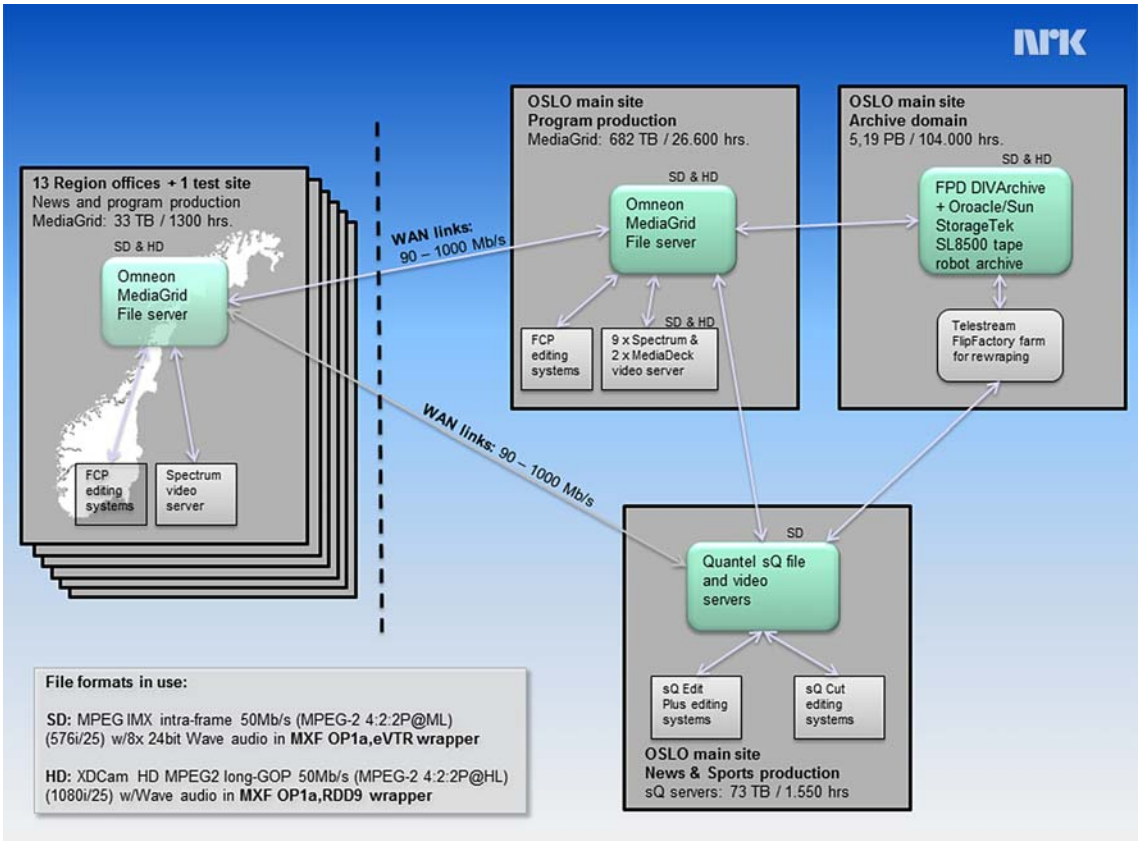


Figure 1
System overview of NRK's infrastructure for television

In Oslo, the News and Sports department uses Quantel equipment for post-production and editing. The remaining types of programming (drama, long-/short-form programming, documentaries etc.) use Apple Final Cut Pro for editing/post-production and Apple Xsan storage. In the Regions of Norway, all forms of programming (news/sports, long-/short-form programming etc.) use Apple Final Cut Pro editing clients with Omneon MediaGrid storage. For ingest and playout, Omneon Spectrum servers are used.

In the first years of file-based operation, errors in many of the files were experienced, especially on the main production server in Oslo which is the MediaGrid. Obviously this is where we have the largest throughput of media files. Many of the erroneous files were sent to the playout area servers for playing out to air. And some were aired with visible and audible flaws.

During this period we were in possession of the MXF Analyser Pro tool from the IRT in Munich, Germany. This QC tool analyses the *wrapper* of MXF files and not the video and audio essence. As more and more errors appeared, the need for a tool that can automatically check both the wrapper and the essence in media files became obvious.

After experiencing several errors on finished programmes, it became urgent to find a suitable tool to help finding the errors and thereby reduce the visible and audible flaws being aired. After research and demos in November 2009 and a specific tip from an existing video server supplier, it was decided to invest in the Interra Systems ***Baton*** product. The choice fell on the MediaGrid version and not the Enterprise Edition version (Windows standalone) in order to save money on server hardware. The MediaGrid version would run on the ContentServers in our existing Omneon MediaGrid.

The MediaGrid version was installed with 16 ContentServer licences in July/August 2010 on our Omneon MediaGrid in Oslo. Six months later we were told that Interra Systems would stop development of the Baton MediaGrid version. This led to a “switch” to the Baton Enterprise Edition. In August 2011 the 16 core licences of the Baton MediaGrid version were transferred to the Baton Enterprise Edition on standalone Windows servers. In addition, another 12 core licences were purchased, making a total of 28 core licences. The reason for this was that an increase in HD material was foreseen and the higher number of licences enabled a more thorough checking of the files.

Between August 2010 and May 2011, the Baton system was used only manually for analysing files that were suspected of having some form of errors. Finally, in May 2011, the automatic watch folders were activated for all files on the Omneon MediaGrid server at the main site in Oslo.

Experiences with our Baton automated file-based QC system

During the time the system has been in use, especially during the setup and initial phases, NRK has gained considerable experience in a number of areas. They are summarized as follows:

- It is important to set up test plans thoroughly to ensure that the analysis is performed according to the parameters that are important to you. One simple example is the check for the number of audio tracks. On the left-hand side in *Fig. 2* is an example of an MXF OP1a eVTR file with IMX 50 video. This contains one

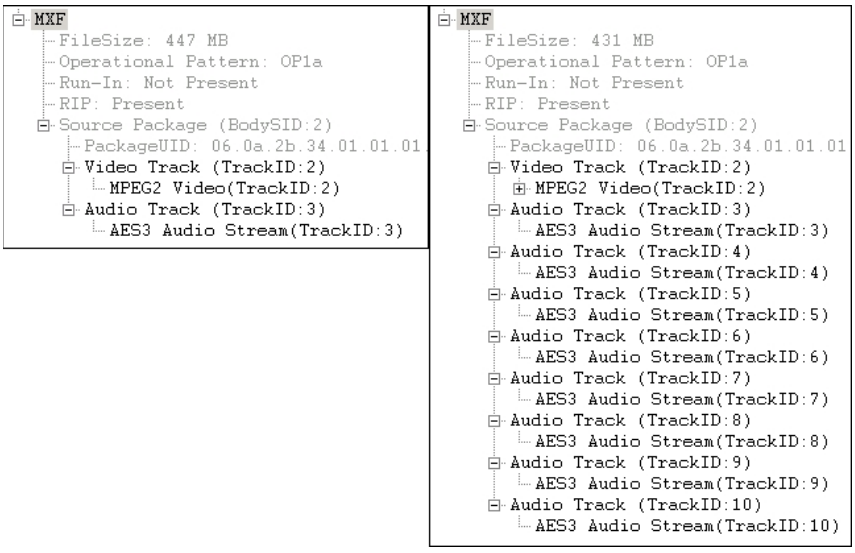


Figure 2
An example of an MXF OP1a eVTR file and an MXF OP1a RDD9 file

audio track with eight audio channels in it. On the right-hand is an MXF OP1a RDD9 file with XDCAM HD422 video. This contains eight audio tracks with only one audio channel in each track. Because of these differences, it is important to set up the test plans accordingly to get the proper result.

- To scale a file-based QC tool is challenging before you have done extensive tests with the tool in question and the parameters you've chosen to check.
- To scale the NRK QC system we did the following:
  - Test plans were made; one for SD and one for HD files.
  - A scheduled automatic check of files was started and left to run for several hours. A status was compiled for the number of files and the amount of data analysed. From that the throughput of the system could be found.
  - One thing to note is that a minor change in a test plan, if the added/subtracted feature is extensive, will often have a major impact on the overall throughput.
- Running more than three simultaneous jobs on a Windows 2003 server, with the Omneon WinFSD (Windows File System Driver) for connection to an Omneon MediaGrid, results in degraded analysis performance (it takes a longer time to read the MXF files).
- Some faults in an MXF wrapped file are not detected as either a warning or an error. Because of this we have also had to rely on a second QC tool for finding specific faults in the MXF wrapper: for instance, the two MXF wrapper parameters "SampleRate" and "Audio sampling rate". *Fig. 3* shows an example where the MXF Analyser Pro tool from the IRT is used. As can be seen, the sample rate has the value 48000/1 instead of 25/1. MXF files with this relatively

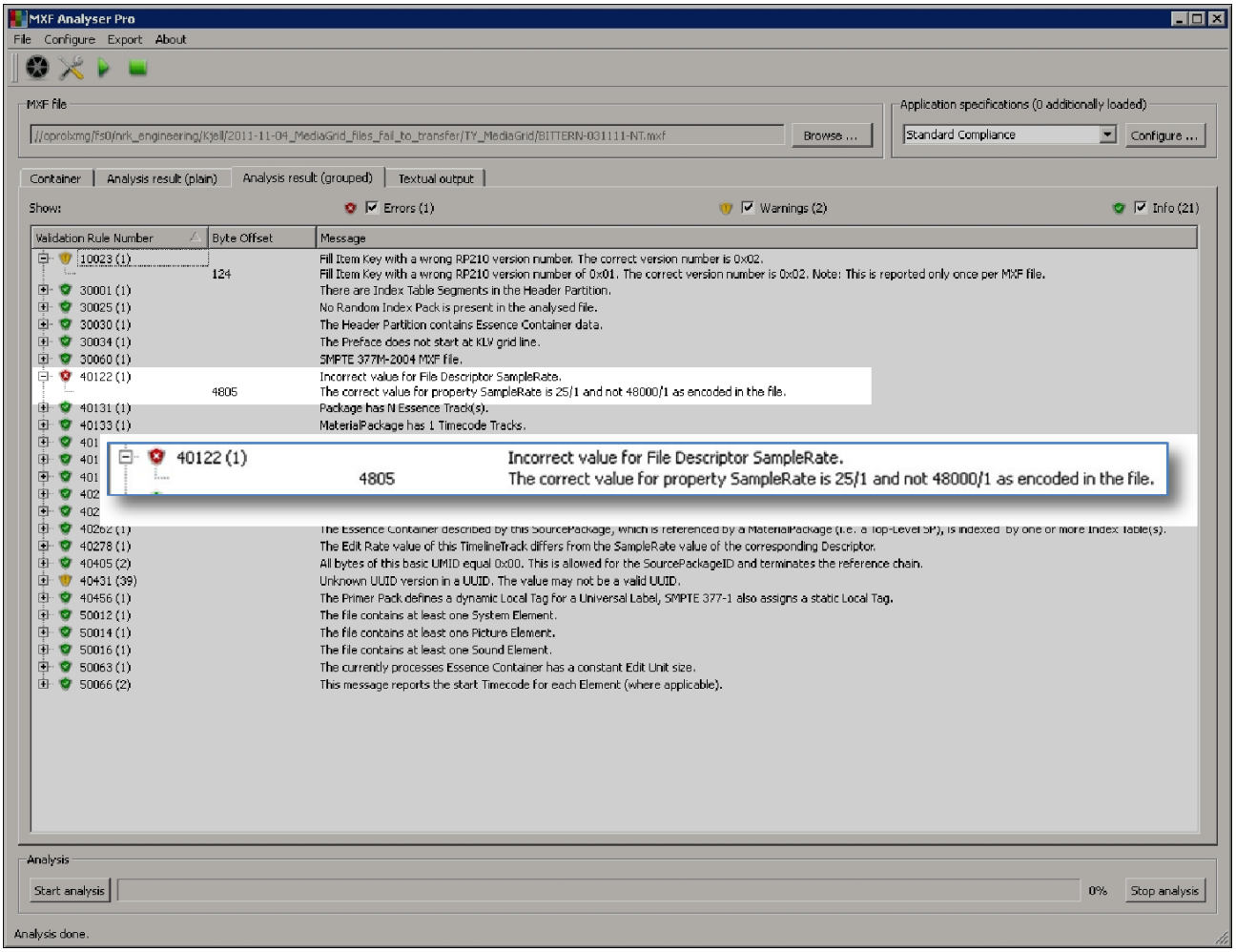


Figure 3
Incorrect value for the SampleRate

small metadata error caused the active transfer of these files to fail between two Omneon MediaGrid servers. For the record, the Omneon Remote Media API that processes such a transfer has lately been enhanced to handle MXF files with such an error.

- There is a problem with the “Video Dropout” functionality in Interra Baton Enterprise Edition versions 3.2.2 and 4.0.1. The functionality is reporting video dropouts at places where there are no video dropouts. It seems that small and bright flashes of light in the video can trigger the “Video Dropout” functionality, and report false video dropouts.
- In general we are satisfied with the support from Interra Systems. Earlier, the support for European customers was based in New York, USA. However, in late 2011, a dedicated support person was installed in Hungary for the benefit of European customers.
- With Baton Enterprise Edition v. 3.3 (current version is 4.0.1), all three relevant EBU R128 loudness parameters, “Programme Loudness”, “Loudness Range” and “True Peak” were in place. In addition to this, you should be able to define exactly which audio tracks and channels shall be included for the loudness measurements (we have not yet tested this).
- Our Baton QC system is configured to analyse all new files on the main production server in Oslo. This totals 600 - 800 new MXF files every day. When the number of recent tasks gets up to a few tens of thousands in the system’s database, the GUI tends to get sluggish. However, the analysing speed for the files is not affected. To prevent this sluggishness it is important to set up an appropriate policy for archiving tasks and for deleting tasks from the archive. This is to keep the system’s database at a manageable size.
- Overall we are happy with the Baton QC system. It has helped NRK in getting an overview of what kind of errors there are in files created in our production systems and the amount of the different errors. This also goes for material from external production houses. The most important errors in our MXF files have so far been:

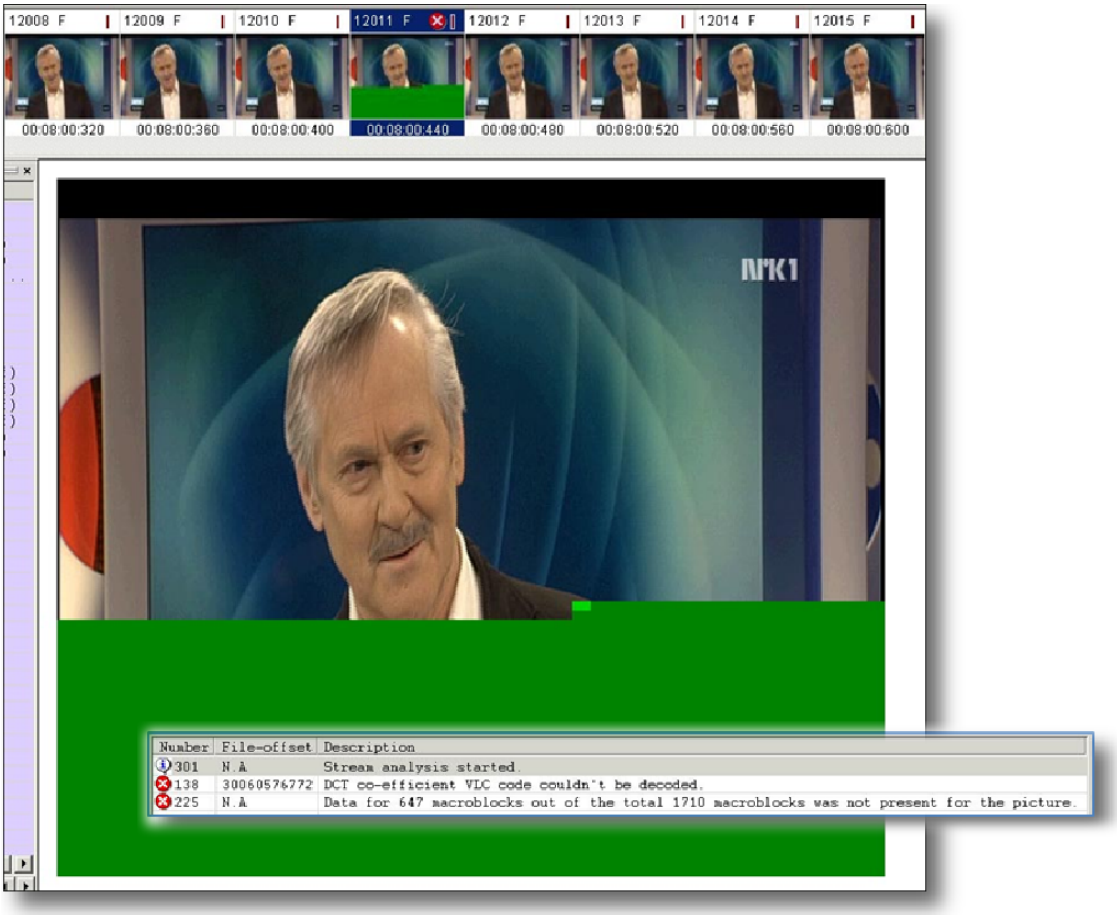


Figure 4
Missing macroblocks lead to corrupt video

- **Invalid KLV keys:** In *Fig. 4* can be seen an MXF file with IMX50 video where there are invalid KLV data which lead to missing data for some macroblocks. This fault was the result of an active transfer from an Omneon Spectrum server to an Omneon MediaGrid, while the Spectrum was recording. The consequence of this fault during playback of the file was a visible corruption in the video and dropout in the audio. This bug has been fully fixed in a recent version of the Omneon Spectrum firmware.
- **Incorrect number and size of body partitions:** *Fig. 5* shows an MXF OP1A file with XDCAM HD 422 video where the partitioning in the file is incorrect.

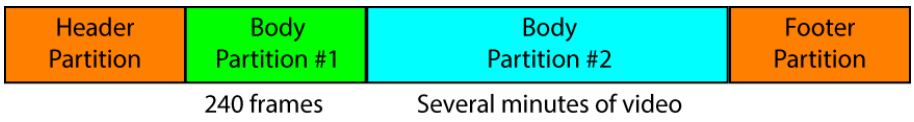


Figure 5
Incorrect number and size of body partitions

This file has been exported from Apple Final Cut Pro using the Sony Cinemon plugin. The problem with this file is that the construction of the MXF wrapper isn't correct according to the "Rdd9-2009" document registered with SMPTE. For systems creating correctly-wrapped MXF OP1a RDD9 files, the target for the body partitions are 240 video frames. Here can be seen a file where the second body partition contains far more frames than the maximum 250 frames.

The consequence of such incorrectly wrapped MXF OP1a RDD9 files is that they cannot be partially restored or transferred with some production systems. In addition, from a certain point in the file and for the remaining part of the file, it plays back with black video and silent audio on some video servers. This bug has been fully fixed in a recent version of the Sony Cinemon plugin.

- **Incorrect GoP structure:** According to the "Rdd9-2009" document, there should be a maximum of 15 frames within one Group of Pictures (GoP) for 1920 x 1080i video. *Fig. 6* shows an MXF file with XDCAM HD 422 video where there is one GoP with one B frame too many.

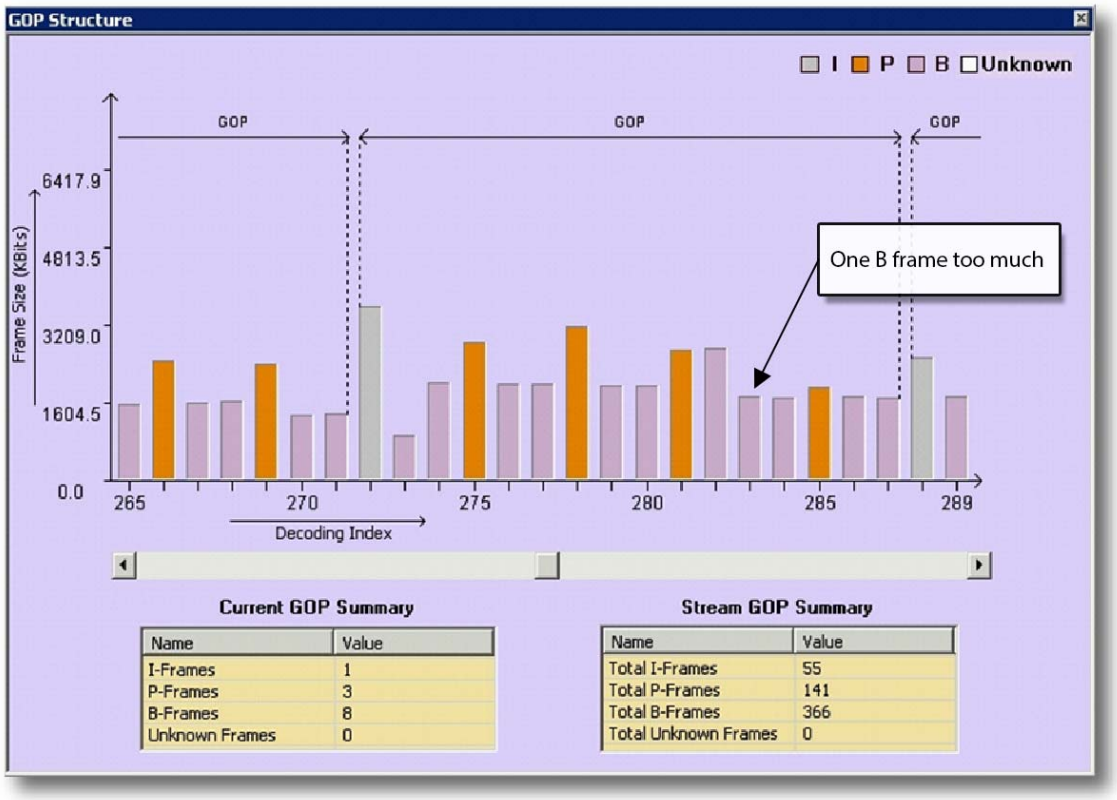


Figure 6
One B frame too much can be critical for certain systems

Instead of the correct 15 frames, this fault leads to 16 frames in the GoP which may give jerky video playback on certain systems.

- **No Footer Partition;**
- **Incorrect field order;**
- **Audio clipping.**

- Basically the QC system has helped us to identify faults with products in our infrastructure and, with the help of the respective manufacturers, has enabled us to solve these issues.
- When fault-finding complex issues, we are also dependant on the two QC tools, IRT MXF Analyser Pro and the Interra Systems Vega Transport Stream Analyser. These tools are for more in-depth analysing of files. The figures above were captured using these tools. However, it is only the Baton product that is used in an automated way.
- The QC system has been set up in a way that, for all files having one or more errors (not including warnings), a PDF and an XML analysis report is written to a specific data share. All these reports are automatically sorted in terms of their error messages. This feature is not included in the Baton software ... it is just a script created in-house. However, currently we do not have the resources of a dedicated person to take care of all these reports on a daily basis. Consequently the focus has so far been on the most severe errors and our attempts to fault-find and solve these.

The Baton file-based QC system – Technical details and throughput

Baton Verification Manager (job distributor server)

- HP ProLiant DL380 G6;
- 2 CPUs; Intel Xeon E5540, 2.53 GHz, 4 cores;
- 12 GB memory;
- Windows Server 2003 R2, 64-bit.

4 Baton Checker servers (analysing servers)

- HP ProLiant DL360 G7;
- 2 CPUs; Intel Xeon X5675, 3.07 GHz, 6 cores;
- 12 GB memory;
- Windows Server 2003 R2, 64-bit.

The throughput of the QC system

During controlled tests, we have measured the throughput of the QC system. In other words, how much SD and how much HD material can it analyse per hour. The test scenarios were as follows.

- Using two CPU cores per analysis task;
- Continuously using three or four simultaneous analysis tasks per Checker server, a total of 14 simultaneous analysis tasks. This equals the total of 28 CPU core licences in the system.
- The test plans used for the automated watch folders have most of the available wrapper checks enabled, and many of the video quality checks. However, deep video quality checks are not

Abbreviations

API	Application Programming Interface	**KLV**	Key Length Value
CPU	Central Processing Unit	**MAM**	Media Asset Management
GoP	Group of Pictures	**MXF**	Material eXchange Format
GUI	Graphical User Interface	**QC**	Quality Control

enabled (like stripe errors check, block errors check, luminance and chrominance levels check, blurriness check and video dropouts check).

- **SD material used in the test:** MPEG IMX intra-frame 50 Mbit/s, MPEG-2 4:2:2P@ML, 576i/25, with 8 x 24 bits (in 32-bit samples) audio channels in AES3 in an MXF OP1a eVTR wrapper.
- **HD material used in the test:** XDCAM HD422 MPEG-2 long-GoP 50 Mbit/s, MPEG-2 4:2:2P@HL, 1080i/25, with 8 x 24 bits Wave audio channels in an MXF OP1a RDD9 wrapper.

One of the results from the two tests shows that it takes about three times longer to check XDCAM HD422 long-GoP 50 Mbit/s HD material as opposed to IMX50 intra-frame 50 Mbit/s SD material.

- For the throughput test with only **SD material**, the measured throughput is 785 GB / 30 hours of SD material per clock hour. Per 24 hours this equals 18,847 GB / 719 hours of SD material. This test was performed over a period of 5 hours and 7 minutes and 549 files / 3.92 TB were analysed. The files were picked randomly in terms of their duration.
- For the throughput test with only **HD material**, the measured throughput is 260 GB / 10.5 hours of HD material per clock hour. Per 24 hours this equals 6,236 GB / 248 hours of HD material. This test was performed over a period of 10 hours and 4 minutes and 480 files / 2.55 TB, were analysed. The files were picked randomly in terms of their duration.

Future changes to the system and its setup

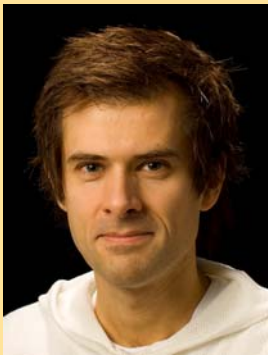
To improve the efficiency of the Baton QC system, in terms of increasing the throughput of the system and spotting more faults in the analysed files, there are some plans for future changes.

Today we have a total of 4 checker servers and one verification manager (job distributor) and 28 core licences. Since all the analysed files reside on our main production server in Oslo, an Omneon MediaGrid, we will strive to only run three jobs on each checker server to maintain the overall maximum analysis speed. Therefore it is planned to expand to a total of 9 - 10 checker servers.

On the main production server there are separate folders for SD and HD material but not for raw material and finished programmes. Therefore the automatic Baton watch folders schedule the analysis jobs for all raw material and all finished programmes for both SD and HD. Since there is not suf-

Kjell Ove Nordlien was born in Lillehammer, Norway in 1974. After achieving a certificate of apprenticeship as a radio and TV repairman, he studied electronics engineering. Later he studied to become a programme technician. In 1998 he joined the Norwegian Broadcasting Corporation (NRK) as an engineer in the video maintenance and support department. At first he worked on VTRs (BetaCam SP, DVCPro and DigiBeta formats) before moving on to supporting and deploying NLE and video server systems.

In addition Mr Nordlien has worked for more than ten years with the systems in NRK's playout area. In more recent years he has concentrated on video servers, transcoding and robot archive systems in the Programme Bank project. Lately, his task has also been one of establishing file-based quality control systems within NRK. In June 2011, he joined the EBU's Quality Control strategic programme which is his first participation in an EBU project group.



Jarle Igeltjørn was born in 1971 in Odda, Norway. He qualified in 1993 as a photographer/editor and went on to edit about 1,000 commercials before co-founding the biggest production company for film and commercials in Norway, The Chimney Pot Oslo. Here he worked as a technical manager for about five years. After that he worked as a freelance vision controller for outside broadcast productions – mainly for OB-team, TV2 Norway.

After his freelance career, Mr Igeltjørn started to work for NRK in 2009, in the file-based workflow department. He is now working with the video archive, video storage, video recording/playout, conversion of media files and quality control.

ficient capacity in our Baton QC system and many of the known errors are in the MXF wrapper, we have so far not enabled deep video quality checking (e.g. stripe errors check, block errors check, luminance and chrominance levels check, blurriness check and video dropouts check) in the automated test plans. But deep video quality checking has been enabled in other test plans that are used manually for suspect files.

There is a need to look at either separating raw material and finished programmes on the main production server, or to have the Baton QC system to differentiate between raw material files and finished programme files. The latter may be done by using the naming convention for the files. This will enable us to utilize test plans with basic checks for the raw material files and thus free up capacity in the system. Thereby it may be possible to enable deep video quality checking in the test plans used for the finished programme files.

Currently we are in the process of developing the functionality of importing file analysis reports in XML format from the Baton QC system to the MAM system which is an OmniBus G3. When this is in place, it will be easier for the users to see whether the media files they work with have problems or not.

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