Digital video archives
– facing the facts

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The EC-funded Euromedia project set out to develop the software components for a basic digital video archive platform. Based on this work, the German engineering company TecMath – who was a Euromedia project partner – has produced a multimedia repository called "MediaArchive".

In this article, the author describes three successful implementations of MediaArchive by public broadcasters in Germany and Austria: ARD BUFFET, SWR FAMOS and the "Euromedia Light" version that has been implemented by ORF.

Introduction

"*Everybody is talking about digitization*" stated Peter Dusek, President of the International Federation of Television Archives (FIAT/IFTA), at a recent symposium held by the German public broadcaster SWR in Baden-Baden. He went on to say: "*This is at the moment our real problem*".

Indeed, there is no international event in the archive community's calendar which doesn't have speech after speech about digital solutions. But when examined more closely, it rapidly becomes clear that only a handful of film and television archivist, worldwide, already have experience in implementing digital video archive systems.

"*Many believe that it is already possible today to do research via the Internet in all TV archives of the world at the same time. But we are seemingly not so far yet*", Mr Dusek added.

The digital revolution is already impinging on the world of TV archives. But what is really possible today? And what experience has been gained by those TV archivists who are already working with digital archive systems?

Over the last five years, the TV archive sections of SWR's predecessors, SWF and SDR (merger completed in 1998), have together been involved in different national and European research projects devoted to digital video archive software. This is reason enough for SWR to try to balance, on the one hand, the rapid developments in the sector of digital archive solutions and, on the other hand, to solve the problems that one is confronted with when organizing the digitization of TV archive material.

The marketplace

Despite the fact that digital video is still in its infancy, there are a lot of companies active in the marketplace.

In the USA, **Cinebase** and **Excalibur** are the key players in this market segment, which is sometimes called *media asset management.* Cinebase [1] – which is a client-server asset management solution that builds and maintains libraries of films, animations, photographs and other visual content in conjunction with a relational database – became well known through its use by the non-profitmaking organization, Survivors of the Shoah [2], which was set up by the movie director, Steven Spielberg. Using Cinebase, the Survivors' *Visual History Foundation* provides on-demand access to over 50 terabytes (10^{12}) of videotaped interviews with Jewish eye-witnesses of the Nazi holocaust.

Excalibur [3] – a traditional provider of advanced retrieval software – is working closely with the BBC and Radiotelevisione Italiana (RAI) in testing Excalibur's *Video Analyzis Engine* (VAE) and other products.

The French TV channel TF1 is using the *Celerra Media Server* by **EMC²** [4] for the storage and company-wide distribution of news programmes. More than 200 journalists will eventually be able to search through all the news items created by the broadcaster over the previous 12 months: selected items will be delivered directly to their desktops as MPEG-2 files, via an ATM network.

Another US product, **Islip** *Media* [5], takes a different approach: via its web-site, Islip is offering a promising solution for the Internet distribution and sale of its customers' video stocks.

These few examples illustrate the wide range of application areas and user requirements that exist for digital video archive systems. Different as they may be, they have one thing in common: digital media archives are leaving the archive shelves behind and are becoming a strategic issue for the whole company [6].

Frequently-asked questions

The first lesson to learn is that a digital archive does not only mean having a large amount of video files somewhere on your company's servers. Advanced video archiving also encompasses the *management* of storing, long-time saving, distribution via local or wide area networks, intelligent retrieval and multiple re-usage of video files. The more different these requirements become, the more diversified become the techniques provided by manufacturing companies to satisfy the broadcasters' needs. Consequently, it is necessary to involve all those who are responsible in the broadcaster's system planning – that includes the IT department, the management and the pre-production facilities. They should all liaise with the documentation and archives department at an early stage in order to build up a sustainable and lasting solution for the whole company. This principle must also be applied in the case of digital television as a whole. Digital TV is much more than what politicians are talking about: it does not only consist of digital uplinking and set-top boxes. If digital TV is to make any sense from an economical perspective, it has to cover the whole workflow of a company.

When planning whatever kind of system in one of the above-mentioned fields, we must start by discussing the necessary file formats: do we really need broadcast quality on every PC or is

it sufficient to offer preview quality? This important question requires a very careful decision – such that future developments and the possibilities for upgrading and extending the system are not compromised.

If a diversified usage, or a modular step-by-step extension, of the video archive system is planned, the next step must be to ensure that the chosen file format can be transcoded (also called transformed) into another file format if necessary; e.g. transcoded from preview or production quality into a format which is suitable for the Internet.

These were just a few of the very basic lessons that had to be learnt by members of the Euromedia project [7], working on the development of a distributed multimedia archive for co-operative television production.

Euromedia project

Staff from the Multimedia Research sections of SWR's predecessors, SDR and SWF, participated – together with the public broadcasters BBC, ORF and SVT – in the Euromedia project, which was funded by the EC's ESPRIT framework. Partners in the technical group were the German engineering company TecMath GmbH (Kaiserslautern), the former European Research Centre (CEC) of Digital Equipment GmbH (Karlsruhe), Helix 5 (the Netherlands) and ITC-IRST (Italy).

Over a three-year period, the Euromedia partners laid the foundation stone for a company-wide audiovisual archive system, which will allow them to introduce digital video archiving on a step-by-step basis at their facilities. The starting point of the project was the fact that in all large film and TV archives today, a textual description of the content of audiovisual material is still created for documentation and research purposes. These descriptions are retrievable over mainframe (host) or client/server networks in textual form. The moving pictures themselves, however, remain stored on conventional carriers such as film and magnetic tape.

In order to view the sequences described in the text database, these substrates must be taken physically from a remote archive storage area and displayed locally on a suitable video playback machine. Only by following this work procedure can the authors or journalists make a selection of suitable video sequences.

Euromedia strategies and measures have been developed to overcome these temporal, material and geographical limitations of the current work routine. The central item is a large-scale digital multimedia archive, which is accessible via local and wide-area networks. The archived video sequences are not *transmission quality* (broadcast quality); instead, for capacity- and cost-saving reasons, they are *preview quality* (MPEG-1). This ensures rapid access to the available video stocks.

Euromedia can be seen as the development of a basic digital video archive platform. It is not a finished, individual, final system; rather, it is like a box of building bricks, or a record of items, which are assembled together.

The Euromedia system consists of five software components:

⇨ an object-relational database management system for the storage and retrieval of media objects and descriptive data;

⇨ an acquisition client for the digitization of video material;

⇨   an indexing library for automated video analyzis of the digitized video material;

⇨   a documentation client for editing the indexing results and for entering descriptive data;

⇨   a retrieval client for full textual searches through the descriptive data and for viewing the results.

The core procedure of the system is *video analyzis*, whereby a digitized MPEG-1 film or video-tape is divided automatically into its sequences. The main elements of the video analyzis pro-cedure are *shot detection* and *keyframe extraction*. These tools make it possible, for the first time, to show the entire picture content of a film or videotape by means of *representative* keyframes (still images) on a single screen page – the so-called *storyboard* or "lighttable". Technically, the storyboard is a list of keyframes linked to transcripts or factual content descriptions, via time-code. The storyboard itself is stored as one JPEG file.

The user interface of Euromedia is based on a common web browser (Netscape). This enables the journalists to investigate picture content from archive copies – on-line via office worksta-tions (or even at home in the case of freelancers), and independent of the office or archive loca-tion.

The result of the video analyzis is not only the storyboard itself (the storyboard is nothing other than the visible part of a list of timecodes). It also lists all detected shots with "timecode in" and "timecode out". This table can be saved on a floppy disk and exported to non-linear editing systems such as Avid Media Composer or Media100. The structure of Euromedia's timecode list is the same as Avid's edit decision list (EDL), the result of the logging process on a Media Composer.

Furthermore, Euromedia offers the possibility of producing a raw-cut version from the stored video material. When creating a special feature, the journalist can assemble a first raw-cut version from the offered storyboards – just by using a "cut-and-paste" functionality. The result is again an EDL-like timecode list. With this functionality, it becomes possible to reduce the necessary digitization of raw material via an Avid to its absolute minimum. Expensive machine-running time can thus be saved.

The system enables a cutter (from the same company or from a private production facility) to produce a raw-cut version of the new product – independent of the journalist or author of a documentary. In this case, two creative processes take place at the same time, independent of each other.

In previous years, it was usual that both the journalist and the cutter – together – previewed all the raw material by digitizing it for the Avid and then together produced a raw-cut ver-sion. Today, time and place do not count anymore. Taking this example only, the implemen-tation and use of Euromedia will save two days work from a total of five days of (at the moment) mostly outsourced editing. Furthermore, savings will be gained on the travelling costs and other expenses of freelance authors.

For documentation purposes, Euromedia offers two user interfaces for manual textual annota-tion. When a storyboard is newly created, one has the possibility of shifting to a writing mode and clicking on each of the keyframes. Behind each keyframe there is a text field, which allows a textual annotation to be made at shot level (and implicit for later developments at frame level). To ease the changeover from the textual database to Euromedia, there is also the possibility of showing all textual annotations in one global text field (with the impression of being one genuine text).
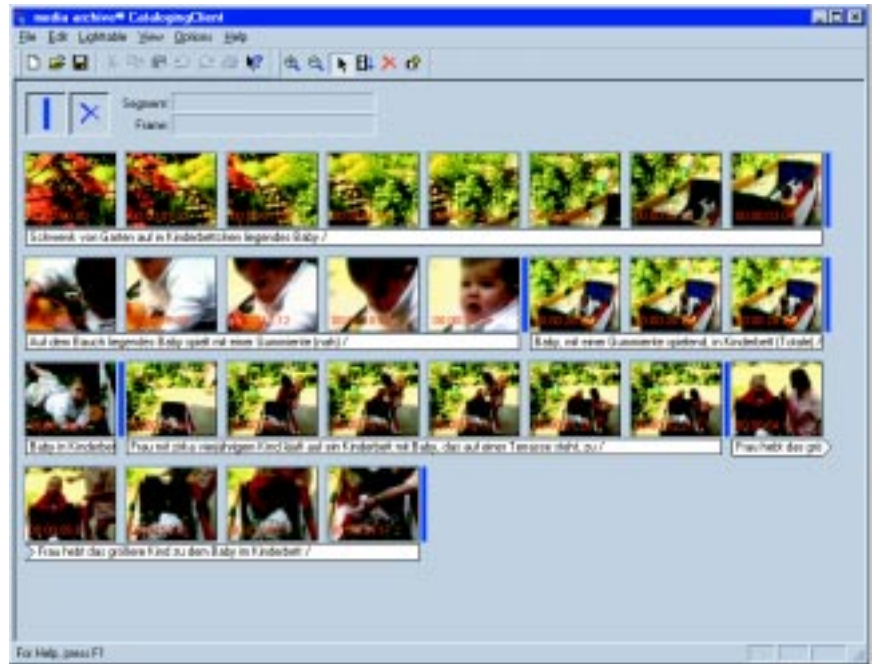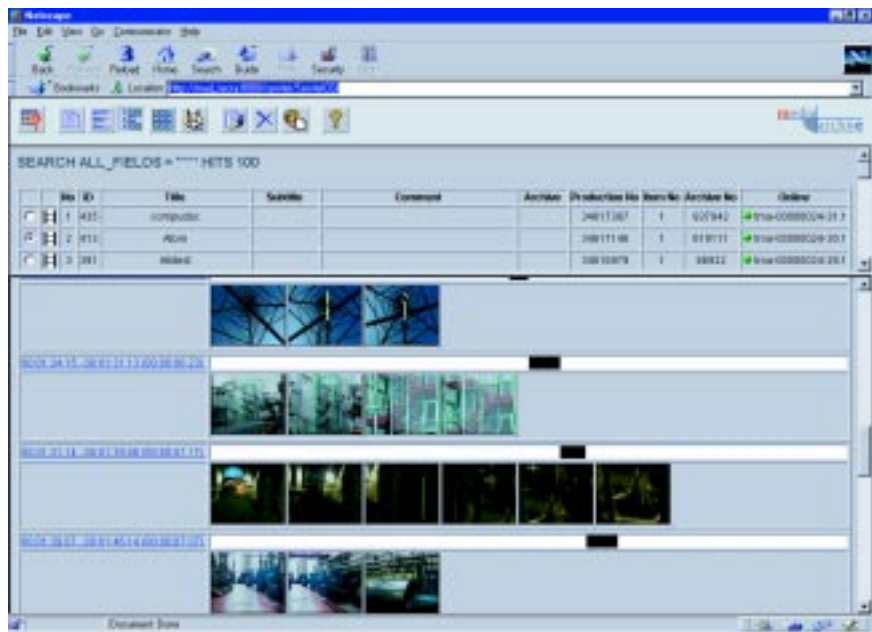
TecMath's MediaArchive

The result of the Euromedia project, in terms of a product, is the *MediaArchive* multimedia repository, which is marketed by TecMath GmbH in Kaiserslautern, Germany [8].

MediaArchive has a client/ server architecture. It supports the complete workflow of acquisition, documentation, archiving and retrieval of audio, video and still image documents. MediaArchive, as offered by TecMath, is designed for use in radio and television production, studio operations, image databases, advertising and news agencies, and in corporate communications. TecMath offers its technology on a modular basis, which means that MediaArchive is customizable. For example, the video storage is scalable from a single-place server up to wide-area distributed systems; interfaces allow the integration of already-existing external applications such as host databases.

The main difference between the project prototype and TecMath's product is that in Euromedia the main programming language was Java – to guarantee a full web-based character. In the case of MediaArchive, TecMath rewrote the code of the cataloguing client in C++, which makes it more secure.

TecMath's MediaArchive – sample storyboard.

TecMath's MediaArchive – pictures obtained from searching via a Netscape web browser.

Implementation 1 – ARD Buffet

SWR decided to adopt a cautious policy when first introducing the MediaArchive system. Initially, it was installed in selected production departments, in order to have a long-term test phase under realistic conditions.

The first implementation was in January 1999 at the production department of *ARD Buffet*, a daily live magazine which includes inserted short, pre-produced, programmes. The magazine is broadcast in two editions daily on two channels; from January 2000, a third daily edition will be added. The production department consists of 80 desk journalists at three sites (Baden-Baden, Mainz, Stuttgart). Three documentalists constantly work solely for this production department.

At *ARD Buffet*, MediaArchive is part of a programme planning system in combination with a text retrieval database, based on Lotus Notes. Within the production department of *ARD Buffet*, there exists a set of 1 200 short, pre-produced, inject films (adapted contributions from all ARD network members). Their core metadata are maintained in the Lotus Notes database. All 1 200 inject films are digitized and archived using MediaArchive but, in contrast to the working routine used, there is only a content description made by the documentalists at present – the disclosure of the picture content is replaced by the possibility of browsing the storyboards. At the moment, there is a growth rate of around 100 films per month. With an average length of four minutes, the films altogether currently need 36 GB of storage capacity.

MediaArchive here runs on 60 PCs that are connected via Fast Ethernet. These are common industrial PCs, but equipped with 20-inch screens. On the storage side, there is a database server, a video server and a RAID array. The database (metadata and content description) can, in principle, also be stored on the same machine as the video server but, for reasons of security and to ease the updating and upgrading processes, it is better to run two machines in parallel. The video files, as the main asset, are stored in a RAID array with a possible capacity of up to 220 GB of data.

Twelve planning editors (chiefs of staff), working to a duty rota, are responsible for the continuous decision-making; they decide which of the inject films ought to be broadcast in the next seven days. Normally, they would do this by previewing a variety of VHS or Betacam SP copies. With MediaArchive, the duty chief of staff can now preview programmes for possible broadcasting – directly on his/her desktop computer, without handling any tape.

Furthermore, the five anchor men and women are also able to preview – via MediaArchive – the inject programmes for the following day. Doing this, they are able to prepare their presentation texts more intensively and even without handling any tape. Using standard multitasking, an additional window with MediaArchive's storyboard or MPEG player is opened to the text processing system.

After half a year of practice now, we have the following experiences to report. In general, the new software tool has been well received in all parts of the production department. The cautious introduction of the system – which did not even replace something else in total – has been seen as a positive policy by the journalists. Because of the special stressful atmosphere of a daily live magazine, not all of the staff were able to work from the very beginning with the MediaArchive system (or found the time to learn how to use it). Those who still want to preview via tapes (maybe at home) can still do that. And for the journalists, it is good to know that the formerly-used working routine still exists as a "back-up".

As in every IT project that is intended to change large parts of well-known workflows, there was a very enthusiastic introductory phase in the acceptance of MediaArchive by both sides – the journalists and the documentalists. This was followed by a second phase of partial sobering up which brought everybody back down to earth. Relatively small technical problems – which in most cases did not have anything directly to do with MediaArchive – led to temporary atmospheres of misacceptance (for example, hardware problems such as malfunctioning cards, etc.).

Against all expectations, the documentalists now have more things to do. The introduction of MediaArchive, of course, is not meant to rationalize jobs (this is a comment which applies to most other IT projects). Documentalists now have a more diversified working area which sometimes leads away from their core business. As the ones who took the initiative for the introduction of the system, they have become a "hot-line" for IT support in general. The time saved because they no longer need to do a manual disclosure of the picture content is, again, absorbed by the time needed for digitizing the videos. Also there is a constant need for training new staff members because of the large number of freelancers and temporary employees at the company.

For the editors (chiefs of staff), the system has become familiar: "*One can comfortably, quickly and easily get an impression of the films, before deciding whether or not to take them into the magazine programme. Thus one receives a much more complex overview of the possibilities and assets*".

Because of dynamic changes in the policy and structure of the live magazine (which is adapted from time to time because of seasonable and professional needs), there is the new experience of having digitized material which is incomplete or will not be necessary anymore. These developments may be unsatisfactory from a documentalists point of view (because storage capacity still has its price), but cannot be avoided in the working routine of a live broadcast.

The following experiences should be taken into account by everybody who is going to plan a similar implementation:

⇨ Do not underestimate storage capacity. What we planned to last for a minimum of one year of additional programmes was used up in nearly six months only. There will always be a wish by journalists – as well as documentalists – to digitize more than originally planned!

⇨ Do implement a hierarchical storage management. One has to decide from the beginning which programmes must be available on-line, and which programmes could be in a near-line (better than off-line) storage. One can then set the criteria for re-use, depending on temporal, content-related, rights-related or programme-planning aspects. The near-line system should be a tape library with a robot mechanism that reduces the access time to two or three minutes.

⇨ "*What we considered to be least important, was the sound. That, today, brings us the most difficulties*" (Robert Fischer, head of R&D section at SWR). Obviously if one wants to view digital video files, one also needs an appropriate sound channel. Common on-board sound cards proved to be unsuitable (deadlock of the players after five seconds). Furthermore, sound coding at only 96 kbit/s was found to cause strong artefacts. A minimum 256 kbit/s is recommended for the sound coding. This will lead to a datastream of 1.3 Mbit/s (for MPEG-1, one usually calculates using an average of 1.5 Mbit/s).

Implementation 2 – SWR FAMOS

The second implementation of MediaArchive aimed to integrate it into the conventional mainframe text retrieval database – FESAD – which is used by most members of the ARD network; it contains around 400 000 database records of SWR alone. The plain structure of FESAD's core software (STAIRS) caused a lot of problems in the beginning, but now there is a working interface between MediaArchive and FESAD. The new interface is called FAMOS and was programmed at SWR's IT department.
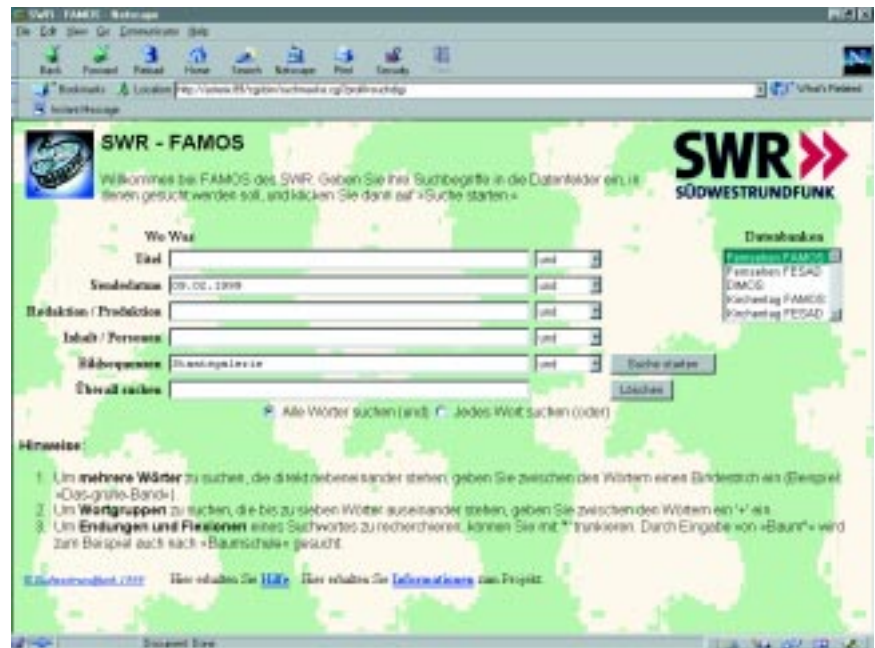
Since March 1999, a test implementation of FAMOS has been running at SWR's site in Stuttgart; the participant here is the production department of the regional daily news magazine *Landesschau* in co-operation with documentalists. The test is being conducted by a project team in the TV archives department.

FAMOS offers several services. All *Landesschau* news items become digitized. As in the *ARD Buffet* implementation, there is an automated video analyzis, resulting in keyframes displayed on a storyboard. But in contrast to the first implementation, the picture content of the short news programmes is fully disclosed at shot level (manually) by the documentalists. Textual data are stored at mainframe level; media data (i.e. video files and still images) are stored on an internal server. Access to the data, along with research on and display of data, are realized via a WWW server, which is where the linking between the textual and the media data takes place. The staff of *Landesschau* have access to the separate textual and media databases and can retrieve all *Landesschau* productions from March 1999 onwards, via either the host system or MediaArchive. All other production departments now have access to very detailed picture descriptions via FESAD.

SWR FAMOS – home page.

SWR FAMOS – picture disclosure at shot level.

But FAMOS aims to be more than just an interfacing of systems. RealVideo™ files of every news item from *Landesschau* are generated from the MPEG-1 file by a transcoding module (also developed during the Euromedia project). Immediately after broadcasting, these RealVideo files are put on the SWR web homepage, thereby giving Internet users access to the regional TV news just a few minutes after the broadcast.

FAMOS was used during the German Protestant Church Days in Stuttgart in June, functioning here as a public video archive for all film contributions about this event.

FAMOS has shown that the role and working routine of documentalists will not become redundant in the future. There is an expectation that documentalists will deepen and intensify the manual content disclosure – down to shot level. It is interesting to see that the importance of text as a retrieval tool will grow in the long run, by means of an audiovisual database aimed at distributing and retrieving the video content more directly.

Implementation 3 – ORF's "Euromedia Light"

ORF, another ex-Euromedia partner, has been running MediaArchive continuously since August 1998 on its intranet. This implementation is a "Euromedia light" version that provides the employees of ORF with keyframe lighttables of all news programmes and most of the magazines of the information department. These are combined with textual annotations imported from the conventional host database (ORF's text retrieval database FARAO is also based on STAIRS software). The annotation granularity remains at news-item level, whereas in a fully-fledged Euromedia implementation, it will be down to shot level.
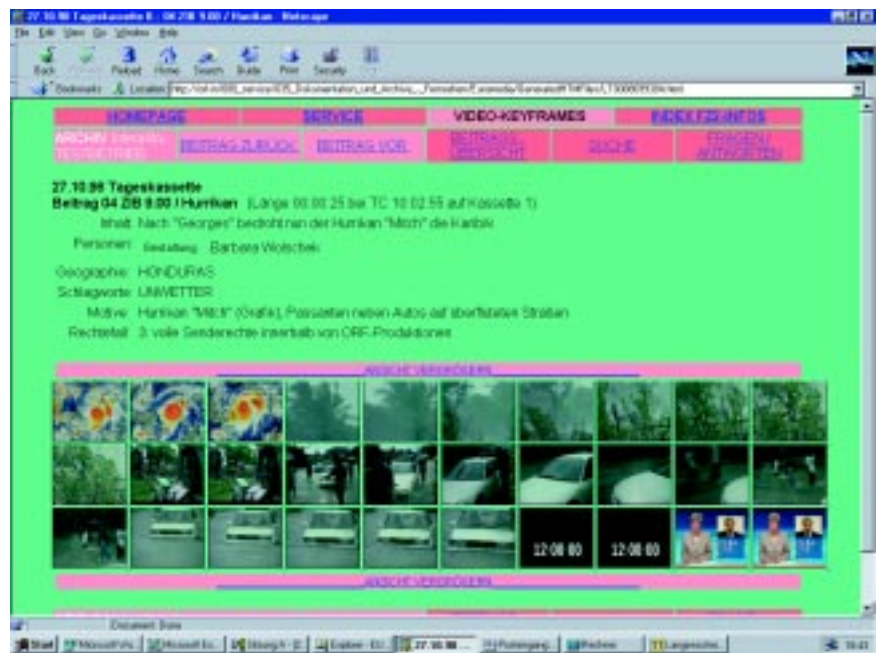
ORF's "Euromedia Light" implementation.

Stored it this way (i.e. represented by keyframes, without the possibility of browsing a streaming video), one complete year of news programmes (365 days times 1.5 hours) requires just 4.5 GB of storage capacity. The user can search the holdings using Microsoft's Index Server which provides very comfortable search functionalities – similar to the very common search engines known from the Internet. Simply by moving the cursor over each keyframe picture, the timecode (in and out) of the original related shot appears in a "pop-up" text box. A lighttable thus provides enough information for the journalist to select large amounts of video remotely, and prevents the borrowing in vain of unsuitable tapes.

By now, more than 600 hours of video have been digitized and keyframed, and are available to *every* employee of the ORF who is connected to the company's intranet which, of course, includes outposts in the region (giving a total of more than 2 000 users).

The company sees this implementation as partly an evaluation and partly a bottom-up implementation of the Euromedia technology. The software's potential modularity can help to keep the considerable technical and financial efforts low. Also, further system decisions are arrived at more easily.

Next step at SWR

The next step at SWR will be the automatization of digitizing, for the benefit of the documentalists. It is planned that the documentalists will take over responsibility for the signal after it has been uplinked by the central VTR.

The timecode on programme items needs to be more exact than it is today. With our current tools (including PC cards), the timecode is not frame-exact. One interim solution would be to write the timecode into the MPEG file. This can be done using a commercially-available encoder rack instead of with PC cards.

Conclusions

The already-realized implementations of the technology developed in the European research project, Euromedia, speak for themselves. Euromedia is a good example of the co-operation between public broadcasters and IT companies. With its open system, its possibilities for mutual applications and the fact that it can easily be integrated into existing television workflows, make Euromedia a valuable building brick for public broadcasters worldwide.

The successful implementation of reference systems at SWR and ORF facilities has encouraged us to continue with our research co-operation, if possible within the fifth European framework (IST).

Our next aim is full integration of Euromedia technology into the conventional database infrastructure. *"We are expecting broader bandwidths in wide area networking in the future; today only RealVideo makes sense but who knows about new file formats for an increasing browsing quality?"* says Robert Fischer (SWR). *"Programme exchange in editing quality may take only another five years of development"*.

One major step towards this goal is currently under development in different projects: the integration of core metadata in the video file format. But that's another story!

Abbreviations

ARD	*Arbeitsgemeinschaft der öffentlichrechtlichen Rundfunganstalten der Bundesrepublik Deutschland* (German grouping of regional public broadcasters)		**IT**	Information technology
			JPEG	(ISO/IEC) Joint Photographic Experts Group
			MPEG	(ISO/IEC) Moving Picture Experts Group
ATM	Asynchronous transfer mode		**ORF**	*Österreichischer Rundfunk* (Austria)
EC	European Commission			
EDL	Edit decision list		**RAID**	Redundant array of independent (or inexpensive) disks
IEC	International Electrotechnical Commission			
			SVT	*Sveriges Television och Radio Grupp* (Sweden)
ISO	International Organization for Standardization		**SWR**	*Südwestrundfunk* (Germany)

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Istar Buscher represented SWR in the EU-funded projects, PopEye and VICAR.

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