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DIVA - the digital video and audio archive of the University Library of Karlsruhe

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Overview:

1. Introduction

In May 2000 the University Library of Karlsruhe released its digital video and audio archive DIVA[1]. Since then the students and researchers of the Karlsruhe University have benefited from a broad spectrum of digital video and audio files. DIVA contains multimedia documents of various subjects which can all be reached at any time over the internet and directly viewed on the personal workplace.

Why did a traditional university library build a digital video and audio archive? Let me first say a few words about our university to understand our motivations:

The Fridericiana Technical University[2] is a modern campus university in the center of Karlsruhe, situated in the Upper Rhine Valley. Founded in 1825, it is the oldest technical university in Germany and has a longstanding tradition in engineering and natural sciences. Today it comprises 12 faculties

[1] http://www.ubka.uni-karlsruhe.de/diva
[2] http://www.uni-karlsruhe.de/Uni/

and current statistics show that Karlsruhe has about 15.000 students enrolled and a staff of about 4.000 people including 300 professors, who work in teaching, research and administration.

The library is - in conjunction with the computer center - one of the central service departments of the university. It holds a collection of about 900.000 volumes and subscriptions for nearly 3000 journals most of them dealing with engineering and science.

As a technical university the Fridericiana is equipped with a highly developed communication infrastructure. Therefore it may not be surprising that the university library also offers a wide range of internet-based services. We were one of the first German university libraries who early on in the 90ths had their own web opac.

The ongoing extension of our electronic services also lead to the development of the well-known Karlsruhe Virtual Catalog[3]. It is a meta search interface to library catalogs that simultaneously searches all German union catalogs plus several major libraries abroad such as the Library of Congress, and retrieves a standardized hit list for the user. Since the Karlsruhe Virtual Catalog is such an unique source of bibliographic information for document delivery and cataloging, users external to the university use it very extensively, and at about 1 million hits per month are registered. The range of our electronic services also comprises document delivery services and various electronic full-text archives[4].

In view of the great expansion of the internet and the increasing possibilities of digital video, our aim was to establish our own digital video archive DIVA in order to extend our electronic services for the university.

An additional factor contributing to this was that the Karlsruhe University is more and more becoming a virtual university. There are several projects in the work area of the virtual university financed by the federal state Baden-Württemberg[5]. Karlsruhe University forms part of some of these[6]. As a direct consequence of these projects, our students benefit from the first multimedia learn modules in various subjects. It is our job as a central service provider to support the further developments of the university. Therefore we became involved in the handling of multimedia documents.

Today we supply our university not only with electronic full-text information but also with digitized video and audio files. Using these digitized media resources, our students and staff are able to create their own interactive multimedia documents where several different electronic media can be integrated via hyperlinks.

2. Launching a project

We wouldn´t have been able to launch such an endeavor without financial and personal support from the federal state government. Here we will explain some of the project settings to give an idea of the background of our digital video and audio archive.

Our library participates in the "Zukunftsoffensive Junge Generation"[7] ("Initiative for the future of the young generation") which is an extensive initative by the regional government in the federal state Baden-Württemberg since 1997 in order to support the future development of information and communication technologies. The projects under this umbrella range from education, media to science and infrastructure topics. More than 40 million DM have been allocated for the modernization of libraries. For this case the Ministry of Science, Research and Art in Baden-Württemberg launched a

[3] http://www.ubka.uni-karlsruhe.de/kvk.html
[4] for example EVA http://www.ubka.uni-karlsruhe.de/eva/index.html; KVVK http://www.ubka.uni-karlsruhe.de/kvvk.html or LEA http://lea.ubka.uni-karlsruhe.de/lea/.
[5] http://www.virtuelle-hochschule.de
[6] for example: http://www.viror.de or http://www.vikar.de
[7] http://www.baden-wuerttemberg.de/zukunftsoffensive/

Multimedia working group of which we are a member[8]. This Multimedia working group consists of 2 computer centers in Tübingen and Ulm, the library service center of Baden-Württemberg (BSZ) in Konstanz and the University Library of Karlsruhe.

The aim of the Multimedia working group is the promotion of the use and offer of multimedia documents in the libraries of Baden-Württemberg.

The Project we introduced into the Multimedia working group was called "enhancement of the usage of audiovisual resources through digitization".

Important aims of our project were the digitization of analogue video tapes and deciding upon the best delivery methods for those digital assets over the internet. A major advantage of the digitization process is that the materials become more easily accessible. Researchers and students are now able to receive them directly to their desktop. Additionally another advantage lays in the possibility for several users to view digital videos simultaneously.

We also wanted to evaluate whether the new technologies in the field of digital video could cope with the typical deterioration of analogue media: the analogue video tapes in many libraries are constantly decaying as they suffer from constant usage. Each copy or play-back deteriorates the original, while in digitized form the master does not suffer any adverse effects, no matter how many copies are taken nor how heavy its usage.
By means of digitizing the video tapes we therefore wanted to find global solutions for the archiving problems of the variety of different analogue video and film standards.

With the product of our efforts and the knowledge gained, we set out to establish our own digital video service.

3. Relevant challenges

The implementation of our project has presented us with a variety of challenges.

3.1. Technical challenges

As mentioned before, our aim was the delivery of the digital video over the internet directly to the computer of the end-user. This involved a lot of questions:

- we do not know the internet connection speed of our end-user, but the availability of sufficient bandwidth is one of the crucial questions in the field of digital video transfer,
- we neither know the configuration nor the power of the user´s computer and accordingly whether or not they can play multimedia files,
- we do not know what operating system or plug-ins are installed,
- another issue is the choice of the digital video formatting; will their quality standards be sufficient and thus be accepted by the students and staff of the university?
- Digital videos means dealing with huge amounts of data; how can we handle them? Which archival system do we need?

3.2. Organizational challenges

In the history of libraries, new media has never completly usurped conventional media. That is to say that by the integration of digital video in the library routine we have to do some reorganisation. We also have to instruct colleagues with the new media and build new and efficient processing procedures.

[8] http://www.bsz-bw.de/diglib/agmm/agmm.html

A key aspect is the indexing of the digital videos and their integration in the library catalogs and the local opac. Yet from the beginning of the project it was obvious that we wanted to benefit from the results of another working group also financed by Baden-Württemberg. The project "Baden-Württemberg Digital Library" established a data model for multimedia objects and we hoped to apply this data model.

3.3. Copyright challenges

Many digital services have to cope with copyright law restrictions as digitization is reproduction and reproduction is regulated. In recent years one could observe that international and national copyright regulations have become weighted in favor of the authors´ rights. In DIVA, we adhere to the German copyright law from 1965, recently modified on September 1st, 2000.

4. Implementing DIVA

4.1. Streaming Media Technology

For the delivery of our digitized video and audio files, we chose to use streaming media technology. Streaming media is a relatively new technology, which began to develop approximately five years ago. The basic idea is to transport video and audio content as a constant data stream over an Internet connection from a so-called streaming server to a remote computer of a user who can view the video content in near real-time using a special player application.

After clicking a link on a web page, a suitable player application opens on the user's PC and requests the video content from the streaming server, which sends the content as a constant data stream to the player. This data stream is immediately used to render the video clip. No download of the entire video file is necessary. (All player applications offer VCR-like control buttons which enable the user to navigate within the video).

On the server side, the streaming server software handles the player requests and sends the video content as data streams to the requesting player applications. Today, server and player software compose a closed, proprietary system.

The representation of moving images on a remote computer screen requires a large amount of information to be sent over the network connection within short periods of time. Technically, such a data stream is characterized by the number of bits transferred per second, e.g. 1 Megabit per second (1 Mbps). This is the central parameter in streaming media technologies as it is closely related to the image quality of the video clip: The more detail visible in a video clip, the more information has to be transferred per unit of time to achieve a smooth play-back .

Before a video can be sent from a streaming server over the network it needs to be encoded into a digital video format. The first step in this process is to digitize analogue video recordings using video grabber cards. This analog to digital transition yields very large computer files, especially when the video is captured in a "frame-accurate" way, i.e. when all 25 frames in one second of a video are coded as individual digital images. In this case, one second of PAL[9] video will yield 31.6 Mbytes of data (768 x 576 x 3 x 25 Bytes), which is more than today's computers and networks can handle. Therefore, it is necessary to drastically reduce the data volume, which can be done for instance by reducing the resolution and the frame rate of the digital video clip. Rendering the PAL video in a resolution of 352 x 288 Pixels and at a frame rate of 15 frames per second already reduces the amount of data by more than 85 percent.
In a second step, the frame-accurate files are used as the input for the encoder software that finally produces the streaming video files. Encoding through software is generally a slow process. It can take

[9] PAL: Phase Alternating Line (television system used in most European countries)

up to 20 minutes to encode one minute of video, and this can be a bottleneck when a video archive is planned to grow rapidly.

The success of a digital video archive using streaming media technologies depends on the ease of use of such a service and its accessibility to the broadest possible range of users. This requirement conflicts with the current situation found on the streaming media technology market where all the major software manufacturers have recognized how lucrative streaming media services in the entertainment sector are likely to be. All manufacturers therefore compete against each other in order to win the largest market share. Today, different streaming systems such as RealVideo, Quicktime and Windows Media, coexist and are best supported on the companies' preferred operating systems. However, no effort is made to develop universal solutions, capable of running on all operating systems (e.g. a universal player that supports all streaming systems and all user platforms).

4.2. Planning a digital video archive

Planning a digital video archive meant that we had to take into account a broad range of possible users who may access the digital video archive using different operating systems and a broad range of Internet access technologies, from slow modem to high-speed local area networks connections.

4.2.1. Operating System of the user PC

While the IT environment in companies is generally homogeneous and centrally administered, at universities it is much more diverse and not centrally administered. Students frequently prefer Linux as operating system for their personal computers, and research projects are often carried out on workstations running a professional version of Unix like Solaris, AIX or Irix. In some departments, Apple Macintosh computers are used, while many others generally use Microsoft's Windows operating system.
In view of this analysis, the digital video archive at the university of Karlsruhe offers video content in all popular video streaming formats: Realvideo, Quicktime and Windows Media.

The Realvideo streaming format from RealNetworks offers the broadest support of different operating systems. Apart from the Windows platform, players are available for the MacOS as well as for different flavors of Unix, like Linux and Solaris. Realvideo therefore fits best our requirement to support a large number of platforms.

Quicktime is Apple's multimedia architecture. It offers much more than only streaming video services. It is the native streaming system for Apple computers, but a player software is also available for the Windows platform.

Windows Media is Microsoft's streaming video technology. A player is available for all 32-bit versions of the Windows operating systems, however it is not pre-installed on the older versions like Windows 95, 98 and Windows NT. Recently, a player software for the Macintosh has been made available.

Additionally, our digital video archive allows users to receive MPEG videos from an IBM VideoCharger streaming server. This additional system is currently being evaluated as it fits into a much larger context, the IBM Content Manager software, which would enable us to build large-scale electronic document management systems.

4.2.2. Internet Connection

Another result of our analysis is that the video content has to be offered in two versions for delivery over slow and fast network links.

In Germany, most of the home users are still connected to the Internet over telephone lines, using a modem or an ISDN[10] card while the workplaces in public organizations and companies are connected to at least a 10 Mbps local area network (LAN[11]). This situation splits the possible audience into two groups: those who are able to receive less than approximately 64 kbits of data per second and those who can potentially receive data streams in excess of 1 Mbit per second (see table 1).

Connection Types	Required Bitrates	Video Resolution	Connection Technology
low bandwidth	40 - 128 kbit/sec	176 x 144	Modem, ISDN, Dual ISDN
high bandwidth	500 - 1300 kbit/sec	352 x 288	DSL[12], WAN[13], LAN 10/100 Mpbs

Additionally, RealVideo and Windows Media Technologies offer features called “SureStream” or “Intelligent Streaming” which promise to cope with the problem of network congestion.

4.3. Production / Workflow

Our streaming media files are produced on two Apple PowerMacs, each equipped with a video grabber card from Media 100[14]. Each card has a different function. One card encodes analogue video in real-time into MPEG-1[15] and MPEG-2 files while the other one produces video files in M-JPEG[16], the frame-accurate format already mentioned in one of the preceding paragraphs. The cards can be connected to a studio video cassette recorder or a DV[17] camcorder. This set-up allows us to capture content from VHS, S-VHS and mini DV cassettes.

In the current configuration, the PowerMac-based encoding station produces all desired formats of streaming video. The PowerMacs have installed Terran Media Cleaner and Adobe Premiere.

Once the encoding into streaming video formats is complete, all files including the MPEG-1 and MPEG-2 files are transferred to a Linux server providing Windows Network Services (SAMBA). This server can also be accessed by the librarian who carries out the indexing work using the DLmeta data model (see next section). Once the indexing is complete, the media files are transferred to an IBM TSM server for long-term storage, along with the metadata file. The streaming media files are also transferred to the streaming servers where they are ready to be delivered to a user.

MPEG-2 is our archiving format, as it supports the full TV resolution and presents the best compromise between image quality and file size. Also, chances are that this format is still up-to-date in 10 or 20 years, as MPEG-2 is the standard used in digital TV in the next decades. It will be used to re-produce our content whenever new streaming media formats replace the currently existing ones.

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[10] ISDN: Integrated Services Digital Network (digital telephone network) transmission of data at 64 kbps (kilobit per second)
[11] LAN: Local Area Network
[12] DSL: Digital Subscriber Line. Data transmission technique which uses the conventional telephone line for data transmission of up to 2 Mbps (Megabit per second)
[13] WAN: Wide Area Network
[14] http://www.media100.com, http://www.wiredinc.com
[15] MPEG: Moving Pictures Expert Group. MPEG-1 and MPEG-2 define two different versions of this digital video standard. MPEG-2 is the standard for digital television, while MPEG-1 describes an earlier version of this standard.
[16] M-JPEG: “Motion“-JPEG
[17] DV: Digital Video

4.4. Streaming Servers

The University Library of Karlsruhe runs three different streaming servers as every streaming media format requires its own video streaming server. Currently, we use an IBM F-50 Enterprise Server with IBM VideoCharger software to stream MPEG-1 videos, a Linux Server for Quicktime and RealVideo streaming and a Windows NT server running Windows Media Services 4 for streaming of the Windows Media files. All servers are connected to a 100 Mbps FastEthernet switch, which in turn is directly connected to the 622 Mbps ATM campus backbone. This configuration would theoretically support up to 60 MPEG-1 streams or approx 180 RealVideo streams at 550 kbits/sec.

5. Copyright restrictions

Solving most of the technical challenges for DIVA was achieved in the first year. What remained for us to overcome were the immense copyright restrictions that had to be dealt with.

The German copyright law regulates in § 53 the reproduction of documents for private und other non-commercial usage . Passage 2, phrase 1 stipulates that it is permitted to reproduce a document, for personal scientific use, if and as far as duplication is necessary for this purpose.

We have interpreted the law to mean that we may offer parts of the protected contents in DIVA only for members of the University. In that way we can guarantee the scientific and non-commercial use of the digitized videos. This approach is relevant to certain scientific television broadcasts, these are recorded and digitized and subsequently presented in DIVA exclusively for campus users. On a technical level, the user's access is managed via their computer's IP address.

As for commercial videos, we have to buy a digitization license from their publisher. These videos are then made available on the aforementioned restricted basis only for campus use. We have bought some of these licenses and are still in negotiation with other publishers. It is fair to say that the publishers themselves very often are confronted with such requests for the first time, which means that they are as new to this process as we are.

Because of these severe copyright restrictions, we would like to increase the number of material produced by university members themselves. In order to do this, we hope that the local multimedia and video production is going to intensify.

6. Contents

DIVA presently consists of nearly 200 hours of digital videos in different video formats. Our main focus is on content related to the university and its lessons and curriculum.

We started DIVA with content from the university TV station and later added the campus radio-broadcast. Both are produced by the university itself, and each month new material is added from the arenas of research and teaching as well as campus life.
In addition, the University and the library itself have produced their own films which are made accessible through DIVA.

DIVA also contains digital videos on different topics such as physics, mathematics, science and history. At the beginning of the video service, our most frequently requested video was a recording from a very famous children's television show "the show with the mouse". This TV show explained in a delightful manner how the internet works. Even computer science professors use this recording for illustration purposes during their lectures.

In the last months our focus has turned to course-related multimedia materials. These are directly connected with the courses at our university.

Here the students can access the university ‘s first online classes. DIVA publishes some introductory courses of the computer science department. The students can also view the online lecture again on their computer at home, independent of time and place. The class is broadcast via an electronic whiteboard and directly recorded in Windows Media Format.

We have also started to support several professors by providing multimedia repositories of information which are used throughout the semester. Students accessing this repository can find audio-visual files which provide a basis for their lectures. Thanks to DIVA they can do this in the comfort of their own homes, or from the computer labs of the university.

Some departments of the university use DIVA as a publishing platform for their own multimedia productions. As an example, the students of the architecture department produce more and more frequently audio-visual projects which they then make accessible through DIVA. However, this capability of DIVA is still in its infancy and heavily depends on the growing awareness of the new service in the University.

For this reason, the library is pursuing an active marketing campaign and is seeking contact with the producers of multi-media documentation at the university. During the selection and recording of materials for DIVA the need for librarian skills become apparent.

7. Indexing and access to DIVA

The last part of this paper outlines the data model which is used to index the video and audio content offered in our digital video and audio archive. DLmeta is the result of the “Digital Library Baden-Württemberg” project[18], whose aim was to evaluate the IBM Content Manager software suite, formerly known as “IBM DB2 Digital Library”. The University Library of Karlsruhe was involved in this project along with the Library Service Center (BSZ) in Konstanz and the computing centers of the Universities of Tübingen, Ulm and Karlsruhe.

One of the central tasks in this project was the definition of a data model which allowed the description of electronic objects stored in the Digital Library. The Dublin Core Metadata Element Set served as a basis for this model. A final version, which had to reflect to some extent the particular architecture of the IBM DB2 Digital Library was adopted at the end of 1998 after intensive discussions between the IT experts and the librarians in the project.

At the end of this project, the idea emerged to re-formulate the “Digital Library” (DL) project´s data model into an XML Document Type Definition[19], taking into account the latest Dublin Core Metadata Initiative (DCMI[20]) recommendations on the Dublin Core Metadata Element Set (DCMES 1.1) and Dublin Core Qualifiers. The aim was to use this model for future multimedia projects.

Today, the “DLmeta initiative”[21] aims to establish this data model as a standard for metadata of multimedia objects in Baden-Württemberg and beyond. The non-commercial use in the research and higher education sector is permitted and welcome. Interested parties can find the complete technical documentation at the DLmeta web site (in German only).

Due to the general nature of the data model, the possible audiences are libraries, archives and museums, or any other organizations dealing with multimedia objects and metadata.

[18] http://www.ubka.uni-karlsruhe.de/allg/projekte/dlbw/index.html, http://www.bsz-bw.de/diglib/ibmdl/
[19] DTD: Document Type Definition
[20] http://www.dublincore.org
[21] http://www.dlmeta.de

The DLmeta data model can be divided into two parts. The first part describes the bibliographic data of the multimedia object according to the qualified Dublin Core Metadata Element Set, whilst the second part describes the technical properties of the multimedia object using elements defined in the" Baden-Württemberg Digital Library" project. Additionally, a "Local" element has been introduced which allows us to extend the XML DTD (XML document type definition) and define data structures necessary to satisfy local needs.

DLmeta combines the strengths of the XML technology with the results of the Dublin Core Metadata Initiative and extends its scope to the technical properties of the multimedia objects. DLmeta is very detailed and offers more than 130 distinct elements and attributes. Together with the extensibility through the "Local" element, this data model is believed to cover the majority of possible applications in the field of electronic resources.

The combination of a powerful framework for the processing of the data in combination with the established standards of the Dublin Core has many benefits. Using well-conceived indexing applications, DLmeta allows the long-term storage of high-quality metadata. XML parsers, in most cases freely available software packages, facilitate the development of new applications that can read, write or update DLmeta data files. The data format is completely transparent through the XML DTD.

At the University Library of Karlsruhe, we are using the DLmeta data model to index and store the metadata of the content in our digital audio and video archive since the end of 2000. Indexing has become particularly simple since the DLmeta Initiative has published the DLmeta editor, a Java application which helps the librarians to generate well-formed and valid XML files without knowing the XML technology.

DLmeta data files of video and audio content which is ready to be published, is sent to the Library Service Center (BSZ), the organization maintaining the union catalog of Baden-Württemberg, so that the files can be processed and imported into this catalog. Subsequently, our local OPAC[22] is updated with the records of the Library Service Center. The digital video or audio content can then be searched using our standard web interface, much like one would search for books or journals.

A so-called "frontdoor" which is a web page with a representation of the metadata and the links to the media files provides the connection between the search result (single hit) and the electronic resource. These "frontdoor" web pages can also be generated automatically from the XML source files using a so-called stylesheet processor. "Frontdoors" are currently static HTML pages stored on the library's web site, but could be replaced by dynamic pages at any time. The use of symbolic URLs like "http://digbib.ubka.uni-karlsruhe.de/diva/2001-1/" to identify the electronic resource, together with the web servers' redirection mechanism makes the metadata representation independent of the underlying web application.

The DLmeta data model used for indexing will also build the basis for further developments of DIVA in the future.

8. Conclusions

In the year following its introduction, DIVA has enjoyed an ever-increasing awareness and popularity amongst the students and staff of the university. Due to this focus on its broad usability during the conception of the video and audio archive, it has become possible to make this new service readily available to a wide variety of uses within the university.
Thanks to the established infrastructure and the gained knowledge by the University Library, DIVA supports lessons of the university with access at any time.

[22] OPAC: Online Public Access Catalog