Technology for Providing Educational Video on Demand on Campus

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Technology for Providing Educational Video on Demand on Campus

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I. Introduction

While there is a lot on TV, it is not there when you need it! Detailed Educational TV schedules are not easily available in advance, and telecast timings cannot suit class timings all over the country. Students lack the motivation to listen to TV programs when they do not meet an immediate need. What is needed is the organized acquisition, storage of TV programs and multimedia material on a local server, and making them available on demand to any one on a LAN as and when they need them. In contrast to digital video recorders designed for individual use, such a system has to work like a professionally managed library meant for a whole institution, rather than for an individual or family. Storing multimedia content in digital libraries is one way of achieving this.

This report describes HP Labs India's contributions in creating tools for use with digital libraries. These tools can be used with several types of digital library software; DSpace, a popular system in open source form is one such. HP Labs have contributed to the creation and development of this system [1]-[3].

The focus here is on acquiring multimedia material such as TV programs and video-clips, and in supporting the creation of interactive multimedia programs by offering raw materials for such development, acquired through educational TV. The tools described help address the problem of inadequate Internet access facilities, and the problem of transmitting metadata - that is machine readable details about the TV programs and video-clips over normal TV channels. The facility that is created places emphasis on institutional use of an organized digital library with multimedia content by hundreds of students who access it through a number of PCs on a LAN.

II. The Problem

Educational institutions in many developing countries serve a large population of students, and impart training in professional and non-professional courses. However, the education sector has not taken full advantage of advancements in information and communication technologies, for handling multimedia. Students require a judicious mix of graphics, audio and video in instructional materials. A multimedia presentation enables the teacher to provide the student with an *experience* enabling the learning of a set of concepts by incorporating video-clips, simulations and animations. Moreover, multimedia can provide

such enhanced or augmented learning experience at a low cost.

Educational TV has seen considerable investments. For instance, in India, the University Grants Commission (UGC) has created a body named the Consortium for Educational Communication (CEC). Attempts by the CEC and similar bodies have culminated in a bouquet of educational channels that are freely available. The CEC also produces video-clips and makes some of them available over the Internet. Despite considerable investments on such items as an educational satellite, EDUSAT, educational institutions still underutilize educational TV. Most students do not get to see the programs. Faculty members rarely go on to make video-clips out of TV programs for use in interactive multimedia presentations.

Over two million students avail of distance education at the university level in India. These students go frequently to any one of several hundred study centers, where multimedia digital libraries can play a valuable role. Another nine million students undergo education in brick and mortar colleges and universities, and they need multimedia digital libraries equally badly. Very few of the colleges outside the metropolitan cities have broad-band connections. They would not be able to take for granted the availability of adequate broad-band connectivity for years to come. PC penetration, in India is still as low as 6%, while the Internet penetration is approximately 3%.

Fifty individual video sessions require considerable bandwidth, which is not cost-effective over an Internet connection. On the other hand, video and multimedia content can be sent through TV channels which reach everywhere. Particularly attractive is the use of direct-to-home (DTH) TV, which offers high quality channel access with very low cost equipment. Such channels deliver MPEG video content and can also make data available using the facilities provided by MPEG to deliver data in parallel to video and audio.

The data transport facility made available to the system has to serve multiple purposes: to distribute schedules in a machine readable form ideally as *.xml files to enable automatic video capture and storage, to distribute metadata describing the content for organized storage, search and retrieval of content, and to distribute presentation and text files such as *.pdf, *.ppt files and *.doc files. Another function of the data would be to describe a number of sub-topics being covered in a TV program, giving them names and indicating their time offsets within a program in relation to the start time. This would facilitate the work of cutting the program into video-clips for use in multimedia presentations.

III. THE NPTEL PROJECT OF THE GOVERNMENT OF INDIA

Funded by the Ministry of Human Resource Development of the Government of India, the National Programme on Technology Enhanced Learning (NPTEL) was run by the Indian Institutes of Technology and the Indian Institute of Science at a cost over Rs 200 Million. This project has created over 200 courses to serve the 1600 engineering colleges of India. The courses, created by the faculty of the apex institutions involved, include recorded video lectures and/or web-based courses. The content created significantly exceeds a terabyte of data. A TV channel, Eklavya, telecasts the video content over a satellite channel. This is a valuable distribution channel for keeping NPTEL content constantly updated at a large number of locations. However, as discussed earlier, the best solution to the delivery problem is to store the content at every campus and make it easily available over the LAN.

IV. THE HP EDUCENTER PROJECT

Having recognized that educational TV holds immense potential in the Indian scenario, HP Labs India had launched the “HP Educenter” Project. This project aimed at creating a working set-up that can be installed in Indian colleges, and will provide a solution for capturing, searching, and using multimedia in the educational process. The main objective of the system is to provide multimedia content over a college LAN on an on-demand basis.

Affordable systems can be set up in college/university campuses. In addition to “importing” content from any storage medium, they can acquire content from educational TV channels[1]. The system is illustrated in Fig 1.

[1] The user institution would have to ensure that they have the necessary permissions to download, store and use such content. This is obviously easier when TV channels are operated by publicly funded institutions.

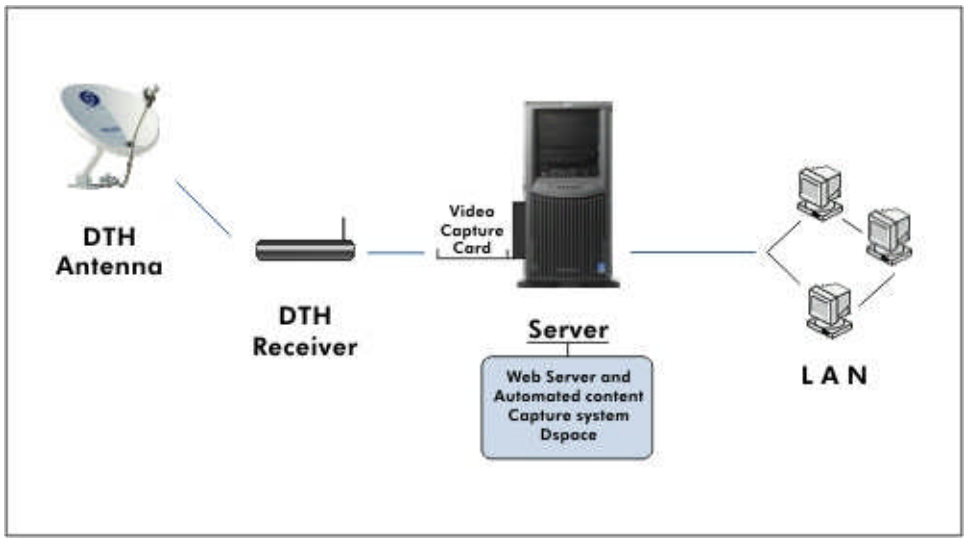

Fig.1. The System Configuration

The capture device encodes incoming TV channel content into MPEG-2 files and stores it on the server. Stored files can then be submitted to a digital library application that runs on the server. The student no longer has to bother about keeping track of TV schedules, or waiting for the right kind of programs. A lecturer can suggest certain videos to be watched as a part of course-work, or the student himself can search the digital library to find what he needs. A built-in search engine available with the digital library makes this easy.

Subject to necessary approvals being given by the college, students can view stored content and even download them into their Laptops. Currently available Laptops can store 100 to 200 video lectures, thereby covering the material taught in a whole semester. Till widespread Laptop usage catches up, students would depend on desk-tops on the college campus to access content.

A prototype system was implemented first and a field trial was conducted at St. Thomas College, Kozhencherry. User feedback was collected. This study also provided a deeper insight into the exact user needs, requirements and technological constraints.

Later, full-fledged working systems have been made available to academic partners who use these systems to promote student learning and give us feedback on their educational value.

V. DSPACE – Digital Library

DSpace is a digital library system [4] that captures, stores, indexes, preserves and provides access to all forms of digital content. Academic and research institutions worldwide use DSpace for meeting a variety of needs such as institutional repositories, and learning object repositories. DSpace is freely available as open source software you can customize and extend. An active community of developers, researchers and users worldwide contribute their expertise to the DSpace Community.

DSpace can be customized extensively to suit the needs of the host organization. Installation is carried out on a Linux-based server[2] that sits on the campus LAN. The system can be used to collect and archive a variety of digital materials including text, images, video, and audio files. This content can be “submitted to” (or, put into) DSpace by any user who has the required authorization to do so. In an educational institution scenario, the faculty could have such privileges. There would also be an administrator with the privilege to accept, catalogue and edit such submissions. This could be a library staff member. Contents of the digital library based on Dspace can be accessed by the users through a web browser.

[2] Recent developments have made it possible to run Dspace on Windows XP [5].

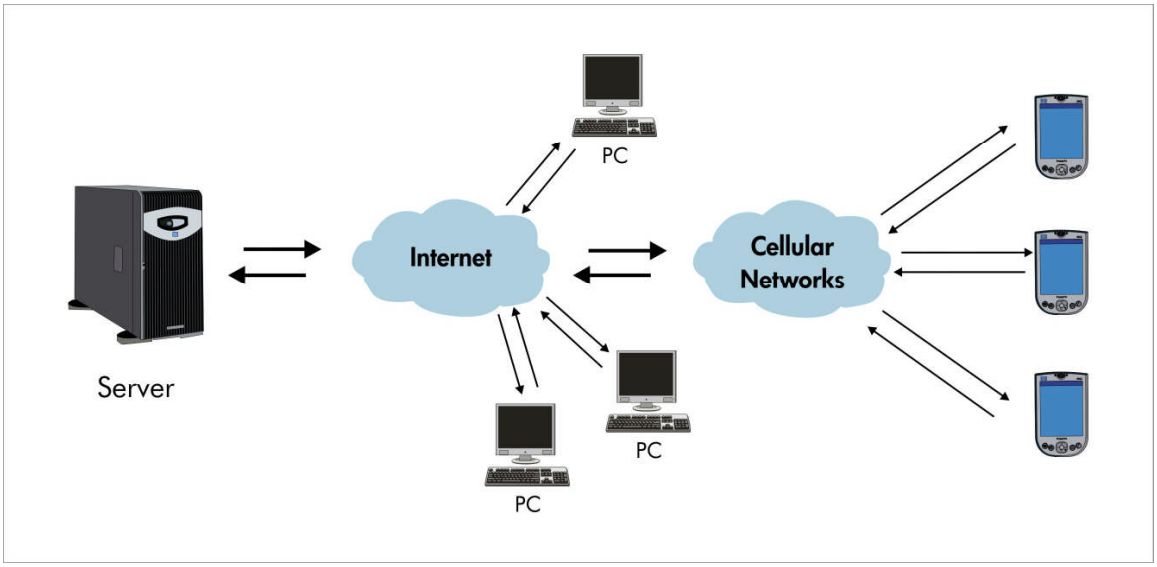

Fig.2. Two Modes of Remote Access to the System

VI. PDAs in Distance Learning

Personal Digital Assistants (PDAs) that provide several valuable tools to on-the-go users can also support educational applications [6]. Of the various models available, the one that was chosen for this project was the HP iPAQ 6365. It comes equipped with all the basic PDA functionalities, and has a built in cell-phone. It can, therefore, be used both for communicating and storing information. It also has several connectivity options including GPRS, WiFi and Bluetooth.

The tools developed as a part of this project enable iPAQs to download and view learning material from educational websites. Textual content associated with programs on a TV channel can be made available on a selected website prior to the program being telecast. Some of the website contents can also be made available to iPAQs over GPRS, thus providing for synchronous delivery of TV programs and digital data. Such content synchronously transmitted with a TV program could include a summary of the program, transcripts of its important audio segments, and a short quiz at the end, which can be evaluated automatically if it is in the form of objective questions. The advantage of using a TV channel and traditional TV receivers for carrying the multimedia component is that it is very inexpensive.

As mentioned earlier, where synchronous transmission of data is unavailable, students could download relevant files in advance. While the TV program is going on, students could be referring to course material, for instance, view graphs and quiz questions through the iPAQ. As in a class room, students may want to pose questions, make comments, or interact with the teacher. The system offers an “Ask Query” link which leads to a new window, using which the student can send a short e-mail to a preset address, or SMS message to a pre-set number.

The expectation is that a team of teaching assistants somewhere on the Internet would be available to answer student queries while the program is being telecast. The teaching assistants could use an application “reading” through the student queries received, matching them to a list of FAQs, and point out any relevant FAQ entry. We are currently developing a prototype system for such student interaction.

As mentioned earlier, universities conducting distance education courses have study centers located in several towns and cities. These study centers have considerable technical infrastructure including broad-band connectivity. Students should also be able to use such facilities to interact with a university system over the Internet. Such traditional access to a university portal would be an alternative to the use of PDAs communicating over cellular communication

channels. The two options should ideally co-exist as shown in Fig.2.

VII. Data Over TV Channels

This section describes tools developed and tested over the last stage of the project. Several TV channels provide content description and brief schedules along with the program. This uses the Electronic Program Guide (EPG) standards. Such metadata obtained in the form of EPG is of limited value to a digital library because it does not offer adequate information to a search engine. Several important educational channels do not provide the EPG material at all. We have provided for the receiving system to construct minimal metadata automatically, when necessary, using the parameters such as the time at which the program is broadcast, the channel name etc.

We have designed and tested out another simple solution. In this case, the institution at the receiving end is expected to subscribe to an email service operated by the organization operating the TV channel. A server at the TV center sends metadata over email, covering all programs it has broadcast that day. A "cron process" running on the server at the receiving end receives the email, identifies it with the particular channel that has sent it, parses the metadata and attaches it to the stored video file.

Recorded videos in MPEG-2 format occupy a lot of space on the system's hard disk. We found it useful to convert the videos into MPEG-4 part 2 format. Then they occupy approximately 500MB per hour of full screen video. This compression reduces both the space occupied on the hard disk and as well as the streaming bandwidth required. Keeping videos in MPEG-4 part 10 is even more efficient than using MPEG-4 part 2.

VIII. Hardware requirements

A server with adequate working memory and disk space is the primary requirement. The CPU needs to be powerful enough to run the video server software selected for use and to support the required number of individual video streams required. Client desk tops use appropriate plug-ins to receive and display content provided by the video server.

The disk configuration should ideally be in the form of RAID, to handle disk failures. If the system does not provide for smoothly handling disk failure, the consequences of by loss of content from dozens of sources would be very heavy. Usable disk space of one terabyte or more would normally be required to meet the needs of an educational institution.

TV PVR cards and their satellite versions, informally called SAT Cards, are necessary to capture video content from cable and satellite.

IX. Virtual video clips

A tool developed in this project takes a text file containing metadata entered online, converts it into a suitable format and "imports" it into DSpace. The user's search locates suitable content by using this metadata. This tool also provides for encapsulating offset information in links pointing to video files. Such offset information indicates the start and end locations (in seconds) of a desired video segment with in a video file. This facility enables separate metadata to point to specific "virtual video clips" within a single video file. This allows different searches to be answered with short multimedia responses.

X. Acknowledgements

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