VIDEO STREAMING OF LECTURES VIA THE INTERNET: AN EXPERIENCE

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Abstract

This paper reports on an investigation into methods of efficiently introducing video streaming into subjects in a large Economics and Commerce faculty. Several software options were investigated before finally settling on RealSystems. The paper provides a brief review of the background of the project followed by a general overview of video streaming. The challenges we identified in effective video streaming are outlined together with a discussion of possible solutions. The paper concludes with an outline of key indications from our investigation of this mode of subject delivery.

Keywords

video streaming lectures, audio streaming lectures, multimedia

Background

Teaching in the higher education sector is moving away from the information transfer mode of the past towards a student-centred, contextually meaningful framework for subject delivery that enhances knowledge development, (Barr & Tagg, 1995). There is a recognition that student learning styles vary and that opportunities should be provided for students to learn in a range of different contexts, (Ramsden, 1992). A key factor facilitating this move has been electronic learning technologies that have increased the range of tools now available to academics in their teaching. In this paper we describe the introduction of audio and video streaming technology in the Faculty of Economics and Commerce at the University of Melbourne.

As the use of computers and the Internet has become more widespread in the community so too has its use by students in their studies. Students in the Faculty of Economics and Commerce have indicated an increasing preference for using the Internet to obtain resources for their learning.

Counters on subject web pages have shown that most students frequently referred to these pages during the semester. Importantly, in terms of pressure on faculty computing infrastructure, close to 70% of students accessed the subject web pages from sites off-campus.

Concurrently with the use of the Internet has come a demand for a wider range of learning materials to be presented on subject web pages. In particular, students ask for lecture notes to be published on the web so that they can correct the notes they have taken or so that they can catch up on lectures that they have missed. While skeleton lecture outlines are seen as a useful tool in directing reading for the lecture and tutorial program we do not see the educational value in printing whole lectures verbatim on the web. There is insufficient interactivity in this and there does not seem much to be gained that would not be equally adequately provided in paper form as a workbook or text. Electronic learning materials are best employed when they either accomplish that which is not possible in paper form or where they provide a similar function more efficiently. We wanted students to be actively engaged in the learning process. The provision of the lecture in its entirety though audio and video streaming is seen as one way in which students could be provided with the facility to review lecture material they did not understand the first time through, to add to or amend the notes they had taken in the lecture or to take lecture notes from any lectures they had missed. This requires more student interactivity than the provision of lecture notes and promotes active engagement with the subject. Active engagement stimulates deeper approaches to learning, (Ramsden, 1992; Meyer & Jones, 1993). Several studies indicate that note taking contributes to higher retention and understanding, (Peper & Meyer, 1978; Weiland & Kingsbury, 1979) and that the provision of a full set of written notes by the lecturer contributes to student passivity (Annis, 1981; Kiewra, 1989).

A second reason for the introduction of video streaming was that the faculty's Centre for Actuarial Studies within the Department of Economics had a number of off-site students, many of whom are located in the Asia Pacific area, who required access to videos of the lectures. In the past these students had received copies of videos of the lectures in the mail. Video streaming would avoid the necessity of this cumbersome form of delivery. The Centre has close ties with the Institute of Actuaries where the use of video streaming is currently being explored in relation to its use in the ongoing professional development of Institute members. The third reason for the introduction of video streaming was that there was an identified need to provide students with up to date comment on current issues of importance to the economy. Visitors to the faculty and incumbent academics were a valuable source of this type of comment. The aim was to interview experts on current issues and stream these for lectures and to students as an enrichment to their text and lecture-based materials.

In 2000 the faculty experimented with the audio streaming of lectures. Students could go to the web page and click on the relevant lecture to listen to it again. Audio streaming of lecturers was undertaken in one second year subject of 350 students in the Department of Management Faculty in semester 1 and extended to the first year Department of Economics subject, Introductory Macroeconomic with 1250 students in semester 2, 2000. Audio streaming has been further extended to two additional subjects in the Faculty in 2001.

Student use of audio-streamed lectures was high in 2000 and 2001 judging from the log of students accessing the lectures. Approximately 15% of students used the audio streaming facility during the semester. This percentage increase to around 25% in the weeks leading up to the examination period indicating that many students see this as a useful aid to revision. It was efficient from the lecturers' point of view in so far as the only additional requirement from them was to arrange for the audiotapes to be delivered to the faculty Teaching and Learning Unit for streaming.

Efficiency from the student perspective was achieved in that students reported that they were able to catch up on lectures and to revise at times more suited to their life style. Much student learning happens outside class, yet lecturers concentrate primarily on what happens in class (Stark & Lattuca, 1997). The capacity to build on outside class learning through audio streaming was a step forward in providing learning support to a wider range of students than had been previously possible. The confidence we gained through audio streaming initially was valuable in taking the next step to video streaming.

The educational advantages of video streaming are that by actually seeing the lecturer presenting the materials students can pick up more readily on visual signals related to the body language of the lecturer and the video stream provides an enhanced perception of interaction between the student and the lecturer. Student attention is also more readily maintained when there are visual as well as audio prompts. In addition there is the ability to cater to the needs of a diverse range of students. Student learning styles and approaches vary widely and audio video streaming of lectures provides an alternative to face to face lectures that is likely to suit particular groups of students not well catered for by existing 'live' or audio-only lectures (Massey & Zemsky, 1995; Sosin, 1997).Those students from non-English speaking backgrounds may find the lectures easier to understand when the visual and verbal cues are combined in video streaming. Important also is the facility to be able to see how a lecturer constructs a diagram as well as key points of intersection and the effect of a movement of one of the curves. This last is a particularly valuable element in teaching and understanding economics.

The Information Technology staff in the Faculty Teaching and Learning Unit and in the Department of Economics carried out an investigation of the feasibility of introducing video streaming into lectures for both on-campus and off-site students in the Centre for Actuarial studies. The faculty experimented with streaming of small video clips introducing key elements of assignments in two subjects in semester 2, 2000 and were encouraged by the positive response from staff. As a result we applied for and received a Teaching and Learning (Multimedia Electronic Technologies) grant to introduce video streaming into two subjects in the Department of Economics in semester 2, 2001. The streaming technology had improved significantly during the year and we now felt that video streaming was more likely to be effective than we had thought early in 2000.

The term, off-site students, encompasses the broad range of students who wish to access teaching and learning materials from sites outside the university. Students who live in Melbourne as well as rural and overseas students all wish to have access to these materials without having to physically come into the university. It is not the intention, nor indeed the experience, that audio or video streamed lectures replace face-to-face lectures. They are intended to enhance student learning through an alternative context for lectures. 'Live' lectures are clearly a first preference for a range of reasons including the social aspect to attendance at a live lecture and a greater immediacy and the potential for interaction. However, audio and video streaming of lectures clearly has a niche market for distance education students in the Faculty and also for local students for the reasons discussed.

The remaining sections of this paper provide a general overview of video streaming followed by sections on creating and delivering streaming videos via the Internet, problems with video streaming, using RealSystems for video streaming, overcoming video streaming problems and complementing the video presentation with other visual aids. The paper concludes with an outline of key indications from our investigation of this mode of subject delivery.

Overview of Video Streaming

In previous years a key barrier to incorporating multimedia such as video and audio into web pages for delivery via the Internet has been the amount of data that has to be transferred over the network. Using conventional methods, a two-hour lecture video will take an intolerably long time to download via a typical home Internet connection using a 56Kbps modem connected to a telephone line. As well as taking up a huge amount of bandwidth (network space), the downloaded file will most likely take up a large percentage of the hard disk space of the computer to which the file is down-loaded. Only once the download is complete, may the file finally be watched hence downloading will need to begin long before the intended viewing time.

To overcome these problems, video-streaming technology is used. The raw video files are 'encoded' in such a way so that the file is compressed, resulting in a smaller file size. Also, the resulting file format allows the file to be opened and played as it is downloading, hence eliminating having to wait for the download to complete before viewing. Finally, the physical file is not downloaded, meaning that hard drive space is not taken up on the downloading computer.

Creating and Delivering Streaming Videos via the Internet

The entire process of providing steaming videos can be broken down to three major steps. Each step is achieved by using software from one of the multimedia software companies. The main players in the multimedia streaming creation field are currently QuickTime, RealSystems and Windows Media. The three steps are:

1. Create a video file to stream. To create a video for streaming, a raw video file (captured using a digital video camera or digitised from a conventional video tape) must be encoded. To do this, software is available which will compress the file to a smaller size and format it in such a way so that the file may be streamed to a viewer via the Internet.
2. Deliver the encoded file for viewing. Once the file has been encoded, it is ready to be delivered over the Internet. The encoded file is uploaded to a 'Streaming Server'. This server accepts requests for a video from a viewer, retrieves the requested video and begins streaming it to the viewer. The streaming server may be a standard web server but to take full advantage of the functionality of streaming technology, a dedicated streaming server should be set up by installing server software that is also available from the above-mentioned companies.
3. Viewing the video. A video is 'streamed' to a viewer when they request the video from the server. In order for viewers to watch streaming videos, they must have the appropriate player (Real systems, Windows Media or QuickTime). This software is usually freely available from one of the multimedia companies. If the player is already installed, it will be started automatically; if not, the user will be prompted to download it from the appropriate company's web site.

Using RealSystems for Video Streaming

After careful product research and a review of several samples of video streaming created from QuickTime, Windows Media and RealSystems, it was decided to implement video streaming. QuickTime was not adopted as the system does not allow to multiple bandwidths from one source file. For example using QuickTime we would have to create a separate streaming file for each connection type that we hope to stream to, i.e. one for a 56 Kbps modem connection, one for a LAN connection and so on. This adds to production time problems and increases the size of storage required. Windows Media has the disadvantage of taking much longer to deploy and it is more complicated to produce the streamed video. Video quality was not found to be as high as Real Player; however, audio quality in Windows Media was found to be higher. RealPlayer was the system finally chosen for several reasons. It was easy to produce the streamed material on the server and it could stream to multiple bandwidths from one source file cutting back on deployment time and storage space. It is relatively straightforward for students to access the streamed material using this system and video quality is the highest of the three systems.

Three RealSystems products were used to create the Department's video streaming system. These products are outlined below.

RealProducerPlus

This software encodes a raw video file (in this case, an AVI file) or input directly from a media device such as a digital camera into a RealMedia file (.rm extension). The viewer may request to watch the video at anytime. Alternatively, a live broadcast can be created directly from the media capture device without saving to a file. In this case the viewer may only watch the video as it is being broadcast, the video may not be accessed later. RealProducerPlus comes with a number of wizards which makes the encoding process easy. With built-in default settings for a number of pre-defined audio and video types there is no need to for the user to specify individual settings such as capture frame rates and audio sampling rates. For example, possible audio types are voice-only, music or stereo and possible video types are normal-motion or smooth-motion. It is possible to override these wizards and apply custom settings.

One advantage of RealProducerPlus over other similar software is that it is capable of creating a single encoded RealMedia file containing a number of different streams based on target connection speeds, using RealSystems' SureStream technology. This means that a different stream will be downloaded to the viewer depending on their connection speed to ensure the optimal

viewing quality for that particular connection speed. The possible target connection speeds are:

* 28 Kbps modem	* Corporate LAN
* 56 Kbps modem	* 256 Kbps DSL/Cable Modem
* Single ISDN	* 384 Kbps DSL/Cable Modem
* Double ISDN	* 512 Kbps DSL/Cable Modem

The downside to this feature is that the size of the file increases for each extra stream that is created within the file. An example is a 2 hour 10 minute AVI file encoded to a 323 MB RealMedia file when only two connection streams were chosen whereas the same AVI encoded for all eight connection streams resulted in a 600 MB RealMedia file. It would seem that, in order to conserve file storage space on the server, it would be best to know the general connection speed of the intended audience and restrict the encoded file to a limited number of connection streams.

In order to quickly create an encoded RealMedia file for video streaming with RealProducerPlus, we used one of the wizards. The steps involved are:

1. Select an encoding wizard, Encode from File, Encode from Media Device or Live Broadcast.
2. Enter the raw video/audio source, i.e. file or media device.
3. Enter Video clip information such as author, date, descriptions.
4. Select the target audience streams.
5. Select the audio type.
6. Select the video type.
7. Select an output source, file or server to stream from for live broadcasts.

Other features of RealProducer Plus are:

- web page creation wizard to generate a web page to embed the video in;
- a Bandwidth Simulator that generates a preview of the video as it would appear on various connection speeds; and
- a streaming video editor which allows the editing of RealMedia clips.

It was found that the encoding process was simple and intuitive. Encoding was quick and occurred for the most part in real time. The resulting files were of a reasonable size. The added Web Page Wizard, Bandwidth Simulators and Clip Editor were handy tools to assist in the creation of a professional looking final product.

RealServer Basic

Streaming videos may be served from a standard Web server using HTTP protocol. However, a RealServer must be used to stream live broadcasts and to make the most out of RealSystems technology such as SureStream (allowing multiple connection streams in one file). This software from RealSystems is free to download and may be used for up to a year free of charge. The Basic version allows streaming to up to 25 concurrent users. RealServer Plus is quite costly at US$2000 but allows up to 60 concurrent users and has some added features. It is available for all the major UNIX platforms and Windows NT and 2000.

The server is simple to set up and requires minimum network knowledge to get up and running. The server is administered through a web-based console. This console allows the administrator to configure server settings, set security, monitor performance and set up live broadcasts. The streaming server will usually work with a web server to deliver streaming content. The web page will link to a .ram or .rpm file that will contain information referencing RealMedia files requested by the user, located on the streaming server. For more technical information regarding the Real Systems Server refer to the Real website and browse the RealServer Administration Guide.

RealPlayer 8 Basic

In order to watch videos or listen to audio streamed from a RealServer, a RealPlayer must be installed on the viewer's computer. A free version of this player, RealPlayer 8 Basic, is downloadable from the Real website. This is available for UNIX, Windows 95 upwards and the Mac. The player has similar functions as a real video/ stereo with control features such as Play,

Stop, Pause, Fast Forward and Rewind. The screen size is adjustable from a default size to full screen. Equalisers are also available to adjust sound volume and quality. The player may function as a stand-alone application or be embedded within a web page.

Challenges in using Video Streaming

The Faculty of Economics and Commerce is using video streaming in three ways. First, to provide web page embedded videos to off-site students in the Centre for Actuarial Studies, which reflect the experience of being in the lecture theatre. This means the video shows the lecturer talking at the front of the theatre and also the PowerPoint slide presentation, which complements the lecture. It is not important whether or not the fine details of the lecturer can be seen with great quality. What is important is the voice of the lecturer, the general view of the lecture theatre and the slides that are being presented are clear to students. Second, to provide streamed videos of lectures for Melbourne-based students. These students are able to attend 'live 'lectures and use the streamed lectures for revision of the lecture as discussed earlier. Third, to provide short 10 minute interviews with economists to illustrate key issues in current economic events. These provide the basis for tutorial problems or assignments and are used within lectures. They are available on the subject web pages.

From the trials conducted in the Faculty and the Department of Economics it is clear that the problems identified with video streaming do not stem from creating and delivering the videos. There are two principal challenges. These are related to Internet connection speed and the visibility of all teaching materials presented in the 'live' lecture.

Internet Connection Bandwidth

Although, the encoding process compresses the raw video file, the resulting file is still quite large. The video is viewable at a reasonably high quality with a LAN type connection. However, the quality suffers when a video is requested from a user using a low speed Internet connection (i.e. a typical 56 Kbps modem). The amount of data that needs to be sent to generate a good quality video will often exceed the capacity of a 56 Kbps modem. The audio stream quality will not be affected but occasionally the video may appear jerky and on rare cases stop momentarily. Clearly this would be detrimental to student concentration and learning. For as long this quality problem remains the faculty will refrain from using video streaming in any directly assessed piece of work and will also to continue to supplement video streaming for distance students with tape video mailed to these students. However, with improving network technology, higher capacity network connections will progressively become the norm and will eliminate the problems associated with insufficient bandwidth.

In order to establish how the audience would be viewing the streamed online lectures, an online survey was delivered to students in the Actuarial studies distance cohort requesting that they provide information regarding their connection speed to the Internet. Sixty percent of returns indicated that they had cable connection with 23% being on 56 Kbps modems. Based on the collected information, the RealMedia file was encoded using the RealSystems SureStream technology to provide a number of connection streams on one file. The categories of connection speed used by the students were defined in the survey and it was possible to create streams only for the relevant connection speeds, rather than the entire possible eight streams, hence reducing the final file size. The SureStream technology is capable of detecting the connection speed of the requesting user so that each viewer is presented with a stream that represents the optimum quality capable for that speed. There are only 25 students in the actuarial cohort so it was possible to keep track of the connections speeds required. However, when video streaming was implemented for the larger group of over 600 students in Intermediate macroeconomics in semester 2 2001 this restriction was removed and the video was streamed to all possible connection speeds in order to ensure adequate access. This requires more storage space but the access advantages are seen to outweigh the relatively small cost of increased storage space.

The various connection types available to consumers are changing rapidly. Telstra has now made available an ADSL (Asymmetric Digital Subscriber Line) service to home users that may soon replace the traditional 56K modem as the main method of accessing the Internet from home. The ADSL service is delivered via the standard home telephone line and the Internet is always connected to the home PC meaning there is no longer a need to make dial up connections to the internet. The price of the service is around $70.00 per month for home users which is not unreasonable considering many internet service providers are charging as much as $2.50 per hour for Internet access with additional hours costing significantly more.

Clarity of Displayed Images

Multimedia guru, Tim Kennedy, has been quoted several times as saying streaming technology in its current form is about access not quality. Although the videos viewed using video streaming are not of DVD quality, they are sufficient to allow students access. It is a matter of time before networking technology makes it possible to deliver the best quality video over the Internet but in the meantime, the solution is to minimise the problems with video streaming.

Experience with audio streaming in 2000 indicated that this technology was effective and found to be useful by students using current networking technology. The lecturer's voice can be clearly heard even using a 56 Kbps modem. The video image however is relatively small resulting in low legibility of slide materials presented by the lecturer. A key problem then is the visibility of the slides used in lectures. The following solutions to this have been implemented in 2001.

- Original Capture Quality. A major contributing factor to the final quality of the streamed video is the quality of the original captured video. Lighting needs to be carefully considered if the video is not taken in specialist lecture theatres. In addition in order to make the slides legible within the video frame itself the text used should be of a larger font and be of a dark colour on a light background. The user is also able to utilise a feature of RealPlayer that allows the video to be displayed at full-screen size. Although this magnifies the details of the video, flaws in the image are also be magnified. However, even under these circumstances, the legibility of the video streamed slides is likely to be limited
- As noted earlier, it cannot always be guaranteed that the slide presentation in the video will always be of a viewable quality as network connection speeds may change and system resources on the user's computer could affect the level of buffering. To ensure that the slides will always be viewable, it was decided that the video and the PowerPoint presentation would be presented together within one web page. To do this, the PowerPoint presentation was obtained from the lecturer and converted to HTML using the HTML conversion function available within PowerPoint. A web page was written which was split into two frames. The HTML version of the slide presentation was embedded in one frame of the web page while the other frame contained the streamed video. The slide may be viewed with all the associated images or simply as texts hence minimising download time. As the video continually plays, the viewer is able to see the slides changing in the video even if the details of the slide are not clear. The lecturer is also encouraged to state clearly what slide is currently being viewed. When the slide changes in the video, the viewer can manually change the slide in the HTML PowerPoint presentation on the web page.

There are also some peripheral problems associated with video streaming. First, students have to download RealPlayer. While computer-literate students will do this easily others who are less competent in this regard may experience difficulty. Second, some free Internet Service Providers do not allow users to view streamed video so students may have to change providers in orders to be able to access the streamed video. Third, there may be some loss of sound quality as the streaming system detects the type of modem students are using and provides a smaller file which result in some quality loss.

Evaluation and Discussion

Several studies have been conducted in relation to student perceptions of the effectiveness of video as a learning tool, (Hecht & Klass, 1999; Ivers & Baron, 1994) indicating that students find the facility useful. In the Economics and Commerce Faculty, audio and video streaming of lectures is in its infancy and results from a comprehensive evaluation has yet to be completed. Logs of student use have been kept and in semester 2 2001 a survey has been conducted of student perceptions. Preliminary analysis of the survey indicates that 92% of students who access the video-streamed lectures in Intermediate Macroeconomics agreed that this was a useful learning resource. 83% agreed that they would use this resource on a regular basis and the same percentage agreed that they preferred video streaming to audio streaming alone. Disturbingly 33% of students agreed that they would use video-streamed lectures to replace live lectures occasionally. Around 42% of students reported missing lectures occasionally and of these 43% of students reported that they occasionally missed lectures due to work commitments and a further 14% missed lectures due to subject clashes. Given that attendance at 'live' lectures is one avenue through which students connect to the course and to the university it is hoped that this use of the facility is limited to occasional use rather than regular use. Indeed this has been the experience in the faculty to date with lecturers reporting no significant decrease in the numbers of students attending.

An issue that the faculty frequently confronts is the minimum technical knowledge required for students to access the electronic learning technologies offered by the faculty. In order to receive streamed video the student must be able to access the Internet, download the streaming media, install the player, and perhaps configure the machine for optimal performance. This typically causes problems for around 5% of students – a not insignificant number in large subjects in the faculty. The issue of student's technological expertise also raises the question of what minimum hardware and software can we expect students to have in order to be able to participate effectively in the course. Over time the issue of expertise is anticipated to be largely resolved as all students develop the necessary skills. However, the issue of minimum hardware and software requirement is likely to be a constant given the speed of technological change.

A review of the video streaming products available has led to our adoption of the RealSystems suite of products was identified as providing the simplest and best quality results for video streaming. The process of creating and delivering streaming video was quick and simple at a reasonable cost. The SureStream feature allows streaming to viewers of different connection speeds with a single file hence reducing production time. The quality of video when viewed from a high-speed connection was very good but this diminished with low-speed connections. However, it was decided that for the purposes of delivering lectures, with good audio delivery, the video image quality was sufficient even with a low-speed connection. By combining streaming video with the web page embedded PowerPoint slides, off-site students were provided with the best interface to simulate the feeling of physically attending the lectures. As the slides did not have to be viewed in the video, the size of the video window could be made smaller to further minimise the size of the video to be down loaded.

Video streaming, in its current form, proved to be a suitable technology to deliver lectures to off-site students and for the provision of short video kernels for use in the tutorial and lecture program of two large economics subjects in 2001. With expected future developments in networking technology, the quality of streamed video will soon be of even higher quality ensuring video streaming a promising role in the delivery of online education.

Experience in audio streaming and the subsequent move to video streaming in the faculty of Economics and Commerce is seen as a natural progression in the provision of a world class learning environment for our students. We believe we are the first faculty in the University to integrate the use of video streaming in the manner described. Clearly the effectiveness of video streaming in improving student learning and in improving the efficiency of subject delivery requires further evaluation and this will be the focus of developments in the faculty in 2002.

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