UNIVERSITI TEKNOLOGI MARA

EVALUATION OF VIDEO STREAMING QUALITY USING QUICKTIME STREAMING SERVER (QTSS): A CASE STUDY IN FACULTY OF INFORMATION TECHNOLOGY & QUANTITATIVE SCIENCES, UiTM

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATION

A/V	Audio / Video
ATM	Asynchronous Transfer Mode
ASF	Advanced Streaming Format.
CD ROM	Compact Disk Read Only Memory
CPU	Central Processing Unit
DMR	Digital Media Repository
DoS	Denial-of-Service
DSL	Digital Subscriber Line
FDDI	Fiber Distributed Data Interchange
FM	Frequency Modulation
FPS	Frames per Second
FTMSK	Fakulti Teknologi Maklumat dan Sains Kuantitatif
FTP	File Transfer Protocol
GHz	Giga Hertz
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
Kbps	Kilobits per second
KB	Kilobytes
KHz	Kilo Hertz
LAN	Local Area Network
Mbps	Megabits per second
MB	Megabytes
NIC	Network Interface Cards
PC	Personal Computer
QOS	Quality of Service
QTSS	QuickTime Streaming Server
RGB	Red Green Blue

RTP	Real Time Protocol
RTSP	Real Time Streaming Protocol
SMIL	Synchronized Multimedia Integration Language
SMTP	Simple Mail Transfer Protocol
TCP/IP.	Transmission Control Protocol/Internet Protocol
TV	Television
UDP	User Datagram Protocol
USM	Universiti Sains Malaysia
VCR	video cam recorder
V-LANS	Virtual Local Area Networks
WAN	Wide Area Network
.AVI	Audio Video Interleaved
.MPG	Motion Picture Graphic

ABSTRACT

In a more broad definition, video streaming enables real-time or on-demand access to video files via local area networks or Internet. Video streaming files are stored in a streaming server, transferred and played back as it is downloaded by a client using a specific media player, leaving behind no residual copy of the content on the client's device. This technology enables users to view and hear digitized media content over a network without having to wait for the entire media files to be fully downloaded. Revolution in higher learning institutions was initiated by the emergence of video streaming. Streaming of media files perceived as a new tool to support and improve learning activities in academic environment. Many studies have indicated that video presentations are very resourceful and very attractive compared to text presentations. And it becomes even more interesting when these video files can be accessed and viewed real-time and on-demand by the students as an alternative way of revising their lecture content. Video streaming in education environment requires a very large storage, and can support delivery and playback to many simultaneous users that enables students to request for the video, and then play or stop or pause the digital content at their own convenience, without worrying of offending the lecturers. Through this dedicated link students can access learning materials such as lectures, pre-recorded tutorials and presentation anywhere and anytime in the campus network. To solve these issues, the implementation of video streaming application is very much needed. Realizing from this fact, this paper is written to discuss the implementation of video streaming applications in Fakulti Teknologi Maklumat dan Sains Kuantitatif, Universiti Teknologi MARA, Shah Alam and to investigate the video streaming quality that it has to offer. There are two methodologies used namely observation and literature search from previous researches. This paper also discusses the broad view of video streaming, streaming server system employed by the faculty, the format of video files supported by streaming server and its compression standard. In addition to this, issues faced by the streaming system are also investigated and finally some suggestions are made to the faculty to have a better video streaming system implementation in the future.

CHAPTER 1

INTRODUCTION

This chapter is written mainly to provide background of the study. It also gives details of the research questions, objectives, significance, scope and limitations of the study.

1.1 Overview

Video streaming has become one of the most popular uses for the Internet in recent times. The demand for this type of media is growing and new applications must be developed to match this demand. Initially, to play a video media file, first it has to be downloaded to a PC and only then user can display it on user's computer after the download has completed. This method is very slow, and the user has to wait for long periods while the video downloaded before they could play it.

The video streaming phenomena began when real-time streaming was introduced. By using a free commercial product such as RealPlayer, streaming could now be accomplished in real-time. New compression technology allowed the video to be viewed as it is downloaded to its destination. With this method there are only delays while waiting for the first few frames to be transmitted, then further frames are displayed as they are transmitted, as if the video were playing in real-time.

This research on video streaming will start with the background of the research, which explains the need and reasons for conducting the research, the objectives, its

scope, its significant, and the limitations of the research conducted. Then, it continues with Chapter 2, which will elaborate on the related works that have been done by researchers from around the globe. This literature reviews are collected from journals, white papers, websites and books. Methodologies of conducting this research will be explained in Chapter 3. Next, in the analysis and findings, which is the heart of this research, will explicitly clarify what have been achieved and their discussions. And finally, this report ends with some recommendations and conclusion that could be considered for future research enhancements.

1.2 Background of the Research

Internet has initiated a revolution in higher learning institutions. It has transformed learning to a new standard, from an Industrial Age Learning model to the Digital Age Learning model (Jaiballan & Asirvatham, 2004). . One of the technologies, video streaming is fast gaining interest as a new tool to support and improve learning activities in academic environment. A study on on-demand presentation confirms that people find informational video useful (He, 2000) and very attractive rather than text presentations. The problem with text presentation is that students may just skim and browse the content without reading it. Another problem is that in-class learning environment is very rigid and sometimes very stressful to students. They only gain information if they come to the class. Once they miss the class, there will be no same re-lecture will be conducted. To solve these issues, the implementation of video streaming application is very much needed.

Generally, the term video streaming in education environment is perceived as a system or service, which requires large storage of video data. It can support delivery and playback to many simultaneous users. It is desirable for students to access learning materials such as lectures, pre-recorded tutorials and presentation anywhere and anytime in the campus Local Area Network (LAN). In addition, through a

dedicated link, students can request for the video, and then play, stop or pause the digital content at their own convenience, without worrying of offending the lecturers.

1.3 Research Questions

This research study will try to answer the following question:

"What are the factors affecting the performance of video streaming?"
"What are technical specifications of video streaming system used in the faculty?"

1.4 Objective of the Research

By answering the research question the objectives of this study will be reached. The objectives of this study are:

i) To identify FTMSK video streaming technical specification
ii) To identify factors that affect the performance of video streaming in FTMSK LAN

1.5 Significance of the Research

The intended research will provide much benefit to the students as well as to the lecturers. As lecturers start to integrate video, streaming media and other multimedia content in their learning materials, a more creative experience is established for their on-line students. This is viewed to be the preferred learning style of each student in a 'mass customized' model of delivery (Winters, 2001). The significance of streaming media is that the feed is live and naturally near real-time delivery. In the case of communication at the Fakulti Teknologi Maklumat dan Sains Kuantitatif (FTMSK), there are a number of benefits that could be identified.

i) Students

In the new learning environment, learning materials are more accessible, learning are conducted on self-paced basis and learning environment is very convenient regardless of place and time. Video streaming application gives students opportunities to review classes, multiple times, through their PCs instead of attending live classes. This will certainly increase student's understanding towards the subject.

ii) Lecturers

As for the lecturers, having video streaming application gives them opportunity to expand their method of teaching.

iii) Faculties in overall

Providing video streaming of campus virtual tours presents an effective way to promote the university as a whole as well as to aid recruitment (Leonard et al., 2003). This is achieved especially during university events such as graduations and sports tournament. In addition, at the beginning of every semester, the Dean could stream a meeting to the new students situated at different lecture halls and classrooms. The Dean will only need to address all of them together at one time by streaming the keynotes in one selected location to several other locations. Students at different places could hear and see the live events at almost the same time.

The system that is still considered at its infancy stage needs a careful and thorough research especially in determining how to stream the video content in a more efficient manner and how to utilize the current infrastructure competently. This is achievable only by investigating the factors that may affect the video streaming quality and by examining other successful implementation of video streaming

systems as a guideline. Then only the most suitable approach regarding the video streaming system could be identified and suggested.

1.6 Scope of the Research

Evaluation of video streaming application as a supporting tool in learning activities is limited to only FTMSK, Universiti Teknologi Mara (UiTM). Data are generally collected from field study.

1.7 Limitation of the Research

In evaluating the performance of video streaming in the faculty, there are several limitations faced by the researcher especially in performing the observation. The streaming server, which is accessible from the Hypermedia Laboratory, is still under heavy testing and indeed very unstable in nature. This lead to inaccurate result in which the video data may sometimes be streamed efficiently from the server but some other time, it seems like forever to view the content. The other limitation would be the use of Mac machine as the admin workstation. Since the researcher is well exposed in using PC, some commands in Apple are unknown. But this is resolved with a small study conducted on how to work with Mac machine from Mac web sites.

CHAPTER 2

LITERATURE REVIEW

The literature is a valuable resource and an important storehouse of knowledge and thinking about a topic or area. This chapter will discuss about all of the information related to the research study. It covers the research on video streaming, the benefits through streaming, and characteristics of video streaming.

The literature review in this paper is based on books, journal articles, on-line documents and web search covering the areas on video streaming and similar or general research.

2.1 Overview Video Streaming

The concept 'streaming' is described as the process of playing a file while it is still downloading (http://www.cswl.com/whiteppr/tech/StreamingTechnology.html).

"Streaming" delivers media, such as movies and live presentations, from a computer (a streaming server) to another computer (a client computer), over the LAN or the Internet. Media can be streamed at various rates, from modem to broadband and files will never be downloaded to the client's hard disk. It breaks data into packets; real time data through transmission, decompressing just like a water stream. A client computer can play the first packet; decompress the second, while receiving the third packet. In this situation, streaming allows user to start enjoying the media data without waiting until the end of the transmission.

A streaming client can connect either to a media server or to a web server to retrieve the media file. User can type the location of the file on the browser address bar or click on a hyperlink to access the media file. Web servers just return a description of the media stream, comprising among the other things, the media server address where the client can actually retrieve the media contents. The dedicated media server performs the actual deliver of streaming media. The load of transferring streams is performed by the media server and thus does not affect the web server performance (Simone, 2003).

The technique allows large media content to be presented and played to the user at a steady rate so that they appear to be real. In other words, streaming plays the media file while it is still downloading. Using a World Wide Web browser plug-in, streamed sounds and images arrive within seconds of a user's click.

The streaming process means ensuring the received audio, motion video, and animation streams are smoothly rearranged to resemble the original stream, and thus be reproduced reliably (Fluckiger, 1995).

Streaming video is never stored on the user's disk. A small buffer may be used to smooth out jitter, but effectively each frame in the stream is played as soon as it arrives over the network (Chapman & Chapman, 2000). Buffering involves accumulating streamed data in a reservoir reside in user's desktop and once a given quantity has been buffered, the data is viewed to the user at a steady rate, which can be greater or less than the initial rate at which it is being transferred to the buffer.

As stated in Webopedia.com, for streaming to work, the client side receiving the data must be able to collect the data and send it as a steady stream to the application that is processing the data and converting it to sound or pictures. This means that if the

streaming client receives the data more quickly than required, it needs to save the excess data in a buffer. However if the data does not come quickly enough, the presentation of the data will not be smooth.

Video materials are digitized and compressed using special production software to create streaming media files. Popular formats include QuickTime, Real Media and Windows Media. The streaming files are then placed on a streaming server (format specific) and accessed through a Web site link. Streaming technology allows multiple users access to any one streaming file at the same time depending on the simultaneous stream license agreement and available bandwidth. To access the streaming file, the user is required to have a player or plug-in installed in their Web browser. Most plug-ins can be downloaded from the Internet for free.

The quality of streaming media is directly proportional to the quality of the original production material (Bruno, 2001). Since streaming software uses compression to greatly reduce the image quality and file size, the final product will be greatly improved if production standards can remain high throughout the process.

Streaming quality is also determined by the users' Internet connection speed for example LAN, Digital Subscriber Line (DSL), Digital Cable, or modem and how well the data network supports video. Streaming media, especially video, does not perform well using modem speeds of 56K or below. LAN and connections to the Internet through T-1 lines should have proper bandwidth capacity as long as the data network supports video through Class or QOS (Quality of Service).

Reliability of streaming media services is greatly improved if housed in a production environment and supported twenty four hours a day, seven days a week, with an appropriate back-up system that will minimize downtime (Bruno, 2001). A server

may also perform better if bandwidth standards are maintained such as 100-BaseT lines originating from the server and dedicated V-LANS from the server to heavily used network areas on campus. Real time streaming media is delivered either in live or on-demand mode.

2.2 Characteristics of Video Streaming

There are three primary characteristics to define streaming media, as explained below:

2.2.1 Streaming Media Technology Enables Real-Time or On-Demand Access to Audio, Video, and Multimedia Content Via the Internet or an Intranet

Streaming technology enables the near real-time transmission of events recorded in video and / or audio, as they happen—sometimes called "Live-Live," and commonly known as Webcasting (Adobe Dynamic Media Group, 2001). Streaming technology also makes it possible to conveniently distribute pre-recorded / pre-edited media on-demand. In other words, media that is stored and published on the Web in streaming formats can be made available for access at any time.

2.2.2 Streaming Media is Transmitted by a Media Server Application, and is Processed and Played Back by a Client Player Application, as it is Received

A client application, known as player, can start playing back streaming media as soon as enough data has been received—without having to wait for the entire file to have arrived. As data is transferred, it is temporarily stored in a buffer until enough data has accumulated to be properly assembled into the next sequence of the media stream. When streaming technology was first available, the ability to begin playback before the entire file had been transferred was a distinct advantage. Now, however,

pseudo-streaming techniques, such as progressive download, allow some other formats to begin to play before file download is completed. So, while the ability to begin playback prior to completing file transfer is a characteristic of streaming, it is not, in and of itself, a differentiating factor.

2.2.3 A Streamed File is Received, Processed, and Played Simultaneously, and Immediately, Leaving Behind No Residual Copy of the Content on the Receiving Device

An important advantage of streaming media, unlike either traditional or progressive download, technology is the copyright protection it provides. No copy of the content is left on the receiving device. Therefore, the recipient can neither alter nor redistribute the content in an unauthorized manner.

2.3 Advantage and Disadvantage of Video Streaming

The old method of watching video from the network was to wait for the entire file to be downloaded onto one's computer then to watch it. Although this could be done through a low bandwidth connection it generally takes a long time to wait for the download and would require a significant amount of disc space to store the file. Streaming on the other hand is a very interesting alternative as compared to the previous method of viewing media content over the network. Users can begin to enjoy a media soon after its download has begun, and do not need to wait for the whole file to be present in the hard disk. The received data rate can be adapted dynamically according to the conditions of the network; this affects the resolution and in general the quality of the played media, which varies according to the available bandwidth.

Entirely downloading a media file is to prefer to streaming when users do not want to immediately play the file, but they rather prefer e.g. to download it overnight and play it when desired. When bandwidth does not allow the stream to be played at a satisfactorily quality, then slowly buffering it, but retrieving it at the highest possible quality could be another choice too.

During the play, the streaming media is only temporarily stored at the client side, and in fact if the user wants to rewind the media it must explicitly request it to the media server, and cannot retrieve it locally. However, some dedicated applications permit storing a streaming media in the local disk.

However, streaming server complexity and cost, both in hardware and in software is relevant. A server capable of transmitting a live event must acquire and convert the media from digital to analog, and then transmitting it to the requiring clients. This clearly requires a certain complexity, as the process of conversion must be performed real time. However, especially if the server is dedicated for transmission of live events, its implementation can be lightened from the support of certain stream control features, like rewind or fast-forward (Simone, 2003).

Simone (2003) also stated that in case of persistent bad network connection, for example low-bandwidth wireless links, the deliver of data to recipient can happen so slowly that eventually the perceived quality of the media is unsatisfactory from the user's point of view. A multimedia stream could result continuously unsynchronized and the user may want to abort the session to try again later to fast-forward the stream to fetch the desired point. If the media file is entirely downloaded before being played, this problem does not appear, provided that the file has been received uncorrupted, and this is a relative advantage of non-streaming technologies over the streaming ones.

There were also copyright concerns because once a file is stored on a disc it can easily be copied and sent to someone else. This would have a harmful effect on artists and companies looking to protect their material, or at least be able to charge people for viewing it, and would likely hinder growth of video and audio applications on the Internet. Streaming a video file on the other hand avoids copyright protection issues because the file is streamed in and out of a computer unlike the download and play method (Morse, 2000). This also solves the problem of disc space because the video does not need to be stored in order to be played.

In addition, streaming reduces the waiting time for watching video files because the video stream can be sent using real-time multimedia specific network protocols and takes advantage of the technique of buffering. The protocols, User Datagram Protocol (UDP), Real Time Protocol (RTP), and Real Time Transfer Protocol (RTSP) differ from the traditionally used Transmission Control Protocol/Internet Protocol (TCP/IP) in that the new protocols, UDP, for example, among other things supports video cam recorder (VCR) like functions such as rewind, fast forward, and pause. RTP is used in conjunction with UDP by adding a ten-byte header to the UDP packets. The header is used to synchronize the graphics of the video and audio packets with each other. Due to latencies and congestion in the network the header also reassembles packets that do not arrive in the correct order in which they are supposed to be played. The other protocol mentioned RTSP can run over RTP and allows for greater control over quality of service and efficiency of delivery. RTSP also has security and management abilities that allow for a content provider to charge for a streaming file. TCP/IP can also be used with the above protocols to perform functions like error checking and the requesting of lost packets.

Buffering is also a factor that allows for near real time viewing. A buffer is an information packet sent in the front of and behind the data packets. Once the buffer reaches the end user it tells the player (Real Player, Quick Time, or Windows Media player) with the help of RTP to wait before playing while enough of the streaming

packets accumulate and get put in their proper order so that a smooth stream will be realized when played. Buffering is necessary for a smooth video because the data packets arrive synchronously or with variable delays between packets. Buffering converts the variable delays to a constant delay so the video becomes a continuous flow of data packets. Data packets with constant delay that can flow in and out of a streaming media player are called isochronous data packets (Morse, 2000).

Before the advent of streaming media technology, multimedia video and audio clips were downloaded as files (usually .AVI or .MPG) to user's hard disk before he / she could view them. Then the file had to be opened using separate software applications like Apple's Quicktime or Microsoft's Windows Media Player. With streaming technology, they are able to view the media clip as it is downloaded, thus there is no waiting for an entire file to download. After a few seconds of buffering the media clip begins playing. In addition, there is no hard disk space required. Streaming media also allows for the viewing of live A/V broadcasts (www.aboutvideoediting.com, 2002).

The true value of video streaming for public speaking classes is not to replace face-to-face instruction or interaction, but to offer students a self-evaluation tool. This technology allows students to view their speeches almost immediately and as many times as they like. Therefore, students would be able to analyze their oral presentation skills and set individual goals for their subsequent speeches. Public speaking instructors could also access the speeches for grading purposes. In fact, video streaming could constitute an excellent learning tool for instructors and students to discuss the strengths and weaknesses of speeches in subsequent individual sessions. Students often do not perceive their speaking incompetencies until viewed after the fact. Because learning styles are so diverse, video streaming could also prove extremely beneficial in meeting most students 'needs (Ross & Schultz, 1999). Students could give their full attention to the instructor during the lecture and then take notes upon watching the tape on line. Notes and PowerPoint

slides could accompany the streaming lectures as well. Samples of famous speeches could be made available for students to watch on line when time precludes such activities during class. Therefore, video streaming technology lends itself to differential or flexible learning, whereby students can access materials whenever they choose and acquire knowledge at their own pace (Owston, 1997).

2.4 Challenges in Implementing Video Streaming

There are a few challenges recognized in implementing video streaming system in a corporate or in Internet environment. Things like bandwidth, how many simultaneous users allowed, archiving, security considerations, content challenges and issues, teacher training, funding and education technology goals are examples of challenges that developers have to face. The following subdivisions briefly described each of the points stated above.

2.4.1 Bandwidth Limitation

Bandwidth refers to the amount of data that can be transmitted over the Internet in a fixed amount of time. For digital devices, bandwidth is usually expressed in bits per second or bytes per second. Some common examples of Internet connection speeds include dial-up modems at 56 Kbps; DSL, which can range from 128 Kbps to 8 Mbps; and T-1 lines at 1.544 Mbps. The broader the bandwidth, the better quality the streaming will be. Many schools, libraries and other places of learning currently do not have sufficient bandwidth to support dependable video streaming; though the technology is coming.

Where bandwidth is an issue, downloading the video file is a practical option. The quality of Internet access is critical. Broadband access will be the new standard. Slow, unreliable connections that cannot support interactivity or right multimedia

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