UKERNA
Video Technology Advisory Service

AN INTRODUCTION TO STREAMING

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Background

There are two main methods for delivering video to a user's computer. The first is for the user to click on a hyperlink and download a video file to their computer for playback. This method requires no special server software. Any computer with a web/File Transfer Protocol (FTP) server running can provide a service based on this method.
The second method is for the user to click on a hyperlink and, after a short wait to allow buffering, the video file starts to play but is never fully downloaded onto the user's computer. This method, known as streaming, requires the user's computer to only store and play the part of the video that the user wishes to view at any one time. In an ideal situation the complete video file is never fully downloaded onto the computer (although this can be enabled), thus protecting ownership of the file and preserving hard disk space. This method requires dedicated server software to handle the Real Time Streaming Protocol (RTSP); it is also the preferred method of presenting video over a network, as Internet Protocol (IP) packets need to arrive in sequence, and forms the basis for the discussion that follows.

What is streaming?

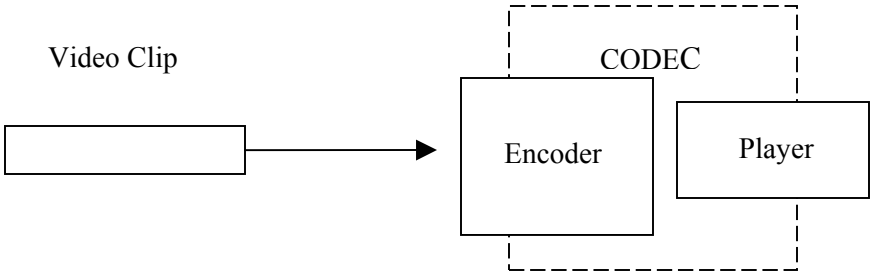
Streaming is the delivery of moving images and sound over an IP network. Such a network may be a Local Area Network (LAN), a Wide Area Network (WAN) or the Internet. The aim of a successful stream should be to provide the best quality picture and sound to the end users based on their connection speed. Intelligent Streaming is the process of intelligently delivering video and audio streams over a network. Intelligent refers to the ability of a streaming server, which holds the video, to determine the bandwidth available to the computer requesting a stream from the server. The server then adjusts the playback of the stream in accordance with the available bandwidth. In practice this means that if a client requests a video stream from a streaming server and is using a 56k modem to connect to the Internet, the server will determine the connection speed and return a narrowband version of the video. Similarly, if a client is on a LAN it may have access to an Internet connection of 10Mbit/s. In this case the server would stream a high quality, or broadband version of the video. The effect of using narrowband and broadband connections is most readily appreciated as one of picture and sound quality. A narrowband connection will result in **lower** quality picture and sound, and a broadband connection will result in **higher** quality picture and sound.

What is encoding?

Encoding refers to the process of preparing a video file for playback over a network connection. Specifically, encoding involves either capturing a source clip (picture and/or sound) from a video source - such as a Video Cassette Recorder (VCR), or using a clip already captured. The clip is then processed using encoding software. The encoding software uses an algorithm to achieve two main aims:

- to reduce the file size of the clip, to enable it to travel across the network in the shortest possible time
- to convert the file format to one compatible with client player software

An encoding algorithm is usually called a CODEC, which is derived from COder/DECoder. A CODEC is used during the encoding process to achieve compression and file conversion. To play back an encoded clip using client player software the CODEC used in the encoding process must be present on the client system in order for the clip to be decompressed.



Multicast or Unicast?

Unicast is the favoured mode of connection used to transmit media over the Internet. In the world of streaming, unicast bandwidth is often the most expensive and critical consideration. For each stream that is viewed by an end user, the server consumes the amount of bandwidth at which the stream is encoded, so for a 32kbit/s stream, 32 kilobits of data are transferred across the network per second for each individual user.

For a scheduled stream or a live stream, multicast can be used (multicast cannot be used with on demand files). If all routers between the server and end users are multicast enabled, then the server can be set for multicast distribution and only one stream is sent from the server, with the routers handling distribution of the packets to the users who request them.

Using multicast can reduce bandwidth consumption, however, there are several types of multicast, and the whole Internet is not multicast enabled. Ask local computer services or network services for more information on multicast. Alternatively see:
http://www.ja.net/development/multicast/

Requirements to be considered

The first step to setting up a streaming server is to consider the following requirements:

- what is the intended audience;
- where is the audience, and how big is it;
- how do they access the Internet, and what bandwidth is available to them;
- what hardware/software is available to the audience;
- what are the available server resources;
- what is the budget?

This will help decide:

- the possible number of simultaneous viewers;
- where the server would be best located;
- what are the maximum and minimum bit rates at which to encode;
- what streaming format(s) to use;
- the work flow of production – capture – encode – upload.

How is streaming implemented?

The first step is to identify a server that is to act as a streaming server. A server currently running other web applications can fulfil this role, although a dedicated server is recommended. Systems administrators are the key people in determining what hardware will be best suited to streaming and should be consulted at all stages of the setup process.

All mainstream operating systems, Solaris™, Microsoft® Windows® NT/Windows®2000, Mac OS®X have streaming software built into the operating systems or are configured to make such software easy to install. Standard computing hardware can act as an efficient streaming server, although as with all applications the more Random Access Memory (RAM), processor power, and the faster, larger disks available, the better. The more powerful the hardware used the more robust and scalable the service will be.

In all organisations it will be necessary to liaise closely with the network administrator and the network administration team as streaming can potentially put a heavy load on a network.

The material will need to be encoded for streaming use. Encoding software comes in a range of prices to suit various streaming needs, the most popular being those with the largest Internet presence – Windows Media® Encoder™ (free), Real Systems Producer™, and Apple® QuickTime® Pro Software players for these formats are currently free.

As with the server, standard computing hardware can act as an efficient encoding station although the more RAM, processor power, graphics memory, hard disk speed and hard disk size available the better. The aim is to produce the best quality viewing experience by using the highest quality source possible. If material is being captured mostly from VHS then a good capture card and VCR are important components of the encoding setup.

The next stage is to test playback on a number of different clients and operating systems. Only through thorough testing can quality of service be guaranteed in any way. If a streaming service is designed to serve users at home with a 56k modem then tests should be carried out to ensure clips play correctly at this bandwidth. Users will need to be informed as to how clips can be viewed, what software to use, how to use the software and who to contact if they cannot get clips to play. Player software ranges between those that function using a Graphical User Interface (GUI), such as Windows® Media® Player, and those that can be command line driven, such as Xanim. There are also streaming test

services such as Streamcheck™, that will regularly monitor and report the stability and availability of a stream.

The final stage in setting up a streaming service is to publicise it. The main access route to streamed material is usually via a website. This website may just include a series of static hyperlinks which when clicked start clips playing in player software. A more advanced site will generate the hyperlinks from a database housed on the server thus reducing authoring costs on the web site. The most important elements in any setup are consistent quality of playback and hyperlinks that are live.

Value for money

In an ideal world everything would be free and easily downloadable, however, like other technologies, streaming can be very cheap or very expensive depending on particular requirements. The following sections explore the stages and costs involved in the video source creation/capture process, assuming operation in a PC/Mac® environment.

A) Content:
Setting up a streaming service pre-supposes content is available to stream, therefore, content should be either on a Super VHS (S-VHS) videocassette, Digital Video (DV) source, or as an Audio Video Interleave (AVI) file on a computer hard drive. In general, collaboration with a media services department will be required, for which a charge may be made, to organise the filming and editing of an event. Expect to pay a sum in the low hundreds.

B) Filming and Playback
Ensure a VCR, or other player is available to play the material to be captured by the computer. VCRs capable of playing S-VHS tapes cost around £400.

If all that is required is a 'talking head' type presentation then it is possible to film this using a camcorder or desktop PC web camera. These come in a range of sizes with varying functionality and almost all are connected to a PC using the Universal Serial Bus (USB) port. All these cameras have the ability to capture low-resolution video in AVI format that is suitable for streaming. Web cameras start at around £30.

Camcorders are more expensive than web cameras. Expect to pay around £450 for a good quality camera. Camcorders can be digital or analogue. Most new consumer units are digital. When specifying a device ensure, if it uses tape, that the cartridges are loaded via the side of the camera rather than the bottom. Units that load from underneath are difficult to use with a tripod because you have to unscrew the camera every time the tape needs changing. Digital camcorders can almost always be plugged into the FireWire® (or IEEE 1394) port on your computer. Some brands of camera use a proprietary version of the standard interconnect leads which require an adaptor to allow connection to a standard FireWire® port.

Software such as Adobe® Premiere (see below) can also control the camcorder directly through the FireWire® connection. Capturing media via the FireWire® port is important

because the quality of the captured clip remains exactly the same as that on the tape original. Other connection options include S-Video, Composite, and RF, but each of these results in lower quality clips respectively.

C) Capture Device:
To work with content held on VHS videocassettes or DV sources, content must be captured to get it onto the hard drive of the encoding workstation for editing. To accomplish this a capture card and an adaptor that allows capture from TV and Video (Composite/S-Video) sources are required. There are many cards on the market that provide these features, from regular PC TV-cards that retail at around £50, to dedicated capture cards that can cost £50 - £500. Factors to consider when purchasing include capture resolution, choice of inputs, operating system compatibility, capture rate, data rate and CODEC.

Capture cards will also often allow audio to be captured via standard RCA inputs. If a card does not support audio, then a separate sound card is needed or the on-board sound capabilities of the computer's motherboard can be used. Whatever audio solution is chosen, ensure that as a standard requirement audio can be captured at a rate of 16-Bit 44.1kHz.

Most capture cards come with software encoders, usually called 'VidCap32', that make use of Microsoft® DirectDraw® technology.

D) Capture/Encoding Workstation:
Having decided on a video source and capture device, a workstation is required to carry out the capture/encoding process. Bear in mind that this machine will be tied up with the capture and encoding process and is unlikely to be free for any other tasks. The workstation needs to be at least a 400Mhz Pentium II® class machine. Any new PC purchased will more than meet this specification but be careful about purchasing cheap machines without first checking that the computer's case can accommodate the range and height of the capture adaptors that may be installed. A regular entry level computer from the likes of Dell™ or Systemax™ will be more than adequate and will cost around £700.

Specifying a very fast and a very large hard drive for the captured material is essential. Capturing video can require up to 20MB per second. Capturing high quality audio takes up less space but is still a significant factor in that one minute of audio can take up to 10MB of space. Disk(s) that can guarantee a sustained data transfer rate of around the 100 Mbit/s will also be required. A typical drive with a 80GB capacity, 7200 rpm, with a data transfer speed of 100Mbit/s will start at around £75. Also bear in mind that a separate system disk in addition to the main capture disk will be required. This disk will host the operating system and program files. A regular 40GB, 5400 rpm hard drive costing approximately £50 will more than suffice for this task.

E) Editing and Encoding:
Once the material has been captured, it will need editing to cut out unwanted scenes and to insert title sequences. If the media services department can complete this, before they supply the source material then it will not only save money, by removing the need to buy video editing software, but also time and hassle.

There are very basic tools available for the editing process. Microsoft® Windows Media® and Virtual Dub tools are free and easy to use. Video can easily be resized, chapter points inserted, that could be used to synchronise with a Microsoft® PowerPoint® presentation, and publish HTML pages to play content. If more advanced editing tools are required then expect to pay around the £500 mark for industry standard tools such as Adobe® Premiere. The benefit of using such tools is control over individual frames, the potential to work with video effects and title sequences, as well as having device control.

Once the video and audio material have been edited, it can be encoded to make it suitable for streamed delivery. The three major proprietary formats for streamed delivery are Apple® QuickTime®, Microsoft® Windows® Media® and RealNetworks RealMedia™. The only format for which encoding tools are free is the Windows® Media® format. To encode material in the other two formats requires the purchase of editing/encoding software solutions such as Adobe® Premiere, Cleaner 5™, or specialist video editing solutions. RealSystem Producer™ for encoding to RealMedia™ format is £143, whereas Apple® QuickTime® encoder is £21.

F) Hosting and Streaming:
A regular web server in conjunction with streaming server software can be used to stream media unless high viewing numbers are expected or a Digital Rights Management model will be implemented, in which case dedicated hardware and software should be purchased. If working in a Macintosh OS®X server environment then QuickTime® streaming services is already installed and requires little setup time to get it up and running. However, only QuickTime® files can be streamed using this software. If working in a Windows® NT®/2000 domain then Windows® Media® Services is easily installed from the setup disk and simple to configure. Only Windows® Media® files can be streamed using this software. To stream RealMedia™ files requires the purchase of a server software solution from Real Systems™. The RealSystems™ server solution costs approx £4,000 and is currently called Helix Universal Server. This product does allow the streaming of all three of the major streaming formats and MPEG standards mentioned above with enterprise level functionality. Do not be put off by high costs though. If you are just starting out with streaming then the entry level free streaming solutions that come bundled with server software are a great place to start.

Summary: If going for the cheapest options expect to pay approximately £900.

(All prices are excluding VAT)

	£
PC Web Cam	30
Capture card	50
Capture/Encoding workstation	700
Fast capture disk	75
System disk	50
Editing software	Free
Encoding software	Free
Streaming server software	Free
Total	**£905**