Digital Video Architectures Compared: QuickTime, Real System, and Windows Media

Introduction:

Technology has come a long way in the last ten years. In the early days of the Internet, we waited patiently in front of our 14.4k modems for each image in a webpage to download. Now we complain about the occasional hitch in the streaming video during a live webcast. Computers are faster, connections are faster, and the software that we use to deliver the video content has improved. This paper will look at the nature of digital video and compare the digital video architectures that have come to dominate the online market. They include QuickTime – originally developed by Apple, Real Video – a product of Real Networks, and Windows Media – the Microsoft version. After the comparison, we will turn to the future of digital video formats and the impact of MPEG 4.

Significance of the Topic:

Digital video architecture refers to "the software responsible for creating, storing and displaying video content (Digital Video, 1997, para. 1)." Because it is charged with fufilling this range of duties, this set of software includes a browser plug-in for viewers to see the final product as well as a number of behind the scenes applications like server software and a foundational program which coordinates with the software that encodes video in a format which can be shared. Over the last ten years, video architectures have arisen and fallen away until the Apple, Windows, and Real Networks versions stand virtually alone. Each has strengths to offer to developers who choose it. In order to understand those strengths fully, we need to begin with a clear understanding of how the process works.

How digital video works on the web:

Bitmap-based web video begins by splitting the images up into a series of files made of rows of pixels along with audio files. The files are transmitted across the web and downloaded by the modem which reassembles the images and sounds and plays the clip. To complete this last step, the user must have a video player, such as Real Player, QuickTime or Media Player. (Aylward, 2000, para. 1&2) (Earlier versions of the players could only read files created specifically for them, but more recent players can read a variety of formats).

The role of codecs:

Codec stands for compression/decompression. This is the program that works with the architecture software to compress very large files into a size small enough to place on a CD, DVD or upload to and download from the Internet in a reasonable amoun of time. The traditional video formats each have several associated codecs – some of

which may come preloaded with video editing software or compression packages. (Maroni, 2001, pg. 5)

How compression works:

Digitized video takes up an unbelievable amount of storage space – "roughly five minutes of uncompressed video will consume nearly one gigabyte of space" (Marioni, 2001, pg. 1) Compression reorganizes or removes data in order to reduce the file's size. There are two kinds of video compression:
1) Lossy – removes information unlikely for the viewer to notice
2) Lossless – retains the original data, but takes out data from areas of the image that use the same (or similar) colors. Lossless cannot reduce files by much more than a 3 to 1 ratio.(Maroni, 2001, pg.3). All three of the video architectures we will discuss use lossy compression.

Bandwidth:

This term refers to the amount of data that can pass through a network connection, usually expressed in terms of kilobites per second (Kbps). Broader bandwidth means a faster network connection – the result is an increased ability to download longer and more detailed video clips or more reliable and detailed video streaming.

Full download vs. streaming video:

Full download video does just what its name says: the entire video content is downloaded before anything plays on screen. Because of the need for the viewer to wait, most full download video clips are no more than a couple of minutes in length (Aylward 2000, para. 7).

Streaming video sets up a buffer – that is, some of it loads, but it begins playing before it reaches the entire download. Streaming helps avoid online 'deadtime' while the viewer waits for the video to load. Most architectures allow the player and server to communicate as the stream begins (or even during transmission) to determine the optimimum clip for the viewer's connection speed. (Aylward, 2000, para.8).

Progressive vs. realtime streaming:

Progressive or "HTTP" streaming is not live, but loads the video clip immediately after the buffer is in place. (Codec Central 2, n.d., para. 4) {Note: the buffer is the audio or video data which reaches the computer faster than it can be displayed – this data is saved in the memory of the client computer.(Codec Central, n.d., para. 4)}The connection does not require a special "streaming server", and the image quality is better than real time streaming. One drawback is that this approach works best for clips of less than about 3 minutes. (Marioni, 2001, pg. 1)

Real time streaming allows the viewer quick access to any part of the clip, but clip itself must reside on a special streaming server. This variety of streaming works better for longer events, such as broadcasts, presentations, or online training, but the ongoing transfer of data means that real time streaming is vulnerable to disruption due to network congestion. (Marioni, 2001, pg. 1)(Fischer and Schroeder, 1999, para. 1). As you will see below, programs use a variety of strategies to overcome this limitation.

Video Architectures Compared:

QuickTime Facts and Features:

- Intended uses include CD-ROM, DVD, and kiosk applications in addition to the Internet. (Codec Central, n.d., 'QuickTime' page)
- Although created by Apple, QuickTime from its earliest versions has been compatible with both Mac and Windows operating systems. Both operating systems are equally well supported. (Codec Central, n.d. para.1)
- The format was designed to support both full download and streaming video. (Aylward, 2000, pg. 3))
- QuickTime Video supports progressive and real time streaming. The "quick start" buffering feature means that users spend less time for waiting for the video clip to begin showing. (Digital Video, 1997, para. 2)
- The real time streaming server from QuickTime was designed for the Mac operating system, but versions are also available for Windows NT/2000, Linux, Solaris, and FreeBSD. (QuickTime 5, 2001)
- Cost: QuickTime 5 – free download
  QuickTime 5 Pro - $29.99
  QuickTime Streaming Server – Free Access
  Darwin Streaming Sever (the open source, multiplatform version of the regular streaming server) – Free Access

Windows Media Facts and Features:

- Windows Media is Microsoft's version of video architecture.
- The current version of Windows Video is 8 (it is due to be released by the end of 2001); the Media Player version is 7.1.
- The early versions of Media were based solely on Microsoft's proprietary .avi raster video format, but recent versions are equipped to deal with a wide range of formats. (WME 2001)
- The current architecture includes a Mac version.
- Windows Media Producer allows for full download or streaming video.
- Options include server based streaming as well as serverless "HTTP" streaming (which uses the conventional Internet server.(WMV8, 2001)
- After compression, each file includes up to five video tracks – as streaming begins, the player and server communicate about the track that best suits the viewer's connection. (Note: Files include one audio track – modem users listen to the same sound as those utilizing the fastest connections.)(Codec Central, 2001, 'Windows Media' pg.)
- Windows Media codecs can drop frames or decrease image quality to maintain real time playback. (Codec Central, 2001, 'Windows Media' pg.)
- The two-pass encoding process produces near VHS quality at 250 kbps and near DVD quality at 500 kbps. (WMV8, 2001)
- Compression includes a variable bit rate to save bandwidth during slow scenes for use during scenes with a great deal of action. (WMV8, 2001)
- Costs: Windows Media Player 7.1 – Free download

Windows Producer – due for release by end of 2001

Real System Facts and Features:

- Originally developed by Real Networks (who are probably best know as the creators of Real Audio), Real System Producer is currently in version 8.5 and Real Video (its format) is in version 8.
- The Real Video architecture was designed exclusively for Internet media delivery – it is not suited to CD-ROM or DVD environments due to high CPU requirements at higher band widths. (Codec Central, 2001, 'Real System'pg.)
- Real Video supports both download and server-based streaming video. (Codec Central, 2001, 'Real System' pg.)
- Full download video is not included. (Fischer and Schroeder,1999, para 1)
- Like the other video architectures, Real Video uses the lossy compression that reduces file size by dropping frames, reducing image quality, or both.(Why?, 2001, para 4)
- The "sure stream" feature allows the web developer to create eight versions of the audio and video tracks. If there is network congestion during streaming, Real Player and the Real Server switch between versions to maintain image quality. (Why?, 2001, para. 8)
- During the compression process, Real Audio codecs are used to encode the soundtrack first, and then the video track is added – this means that playback audio is excellent, but video image may suffer in limited bandwidth situations.
- Real System codecs use two-pass video compression to improve picture quality. (Why?, 2001, para. 6)
- Real Video versions are available for the Windows, Mac, Linux and Solaris operating systems. (Why?, 2001, para. 7)
- Recent versions of Media Editor include timeline-based graphical editing tools.
- Real Video supports SMIL web page code – this allows developers to synchronize media actions within a web page as well as the video and audio.(Codec Central, 2001, 'Real System' pg.)
- Cost: Real Player, Real Producer Basic, Real System Server Basic – free download
  Real Player Plus – $29.99
  Real Producer Plus - $199.95
  Real System Server Plus - $1995.00

MPEG 4 Hits the Scene:

MPEG is not a video architecture, nor is it exactly a codec. It is a standard file format and set of compression algorithms which were (and continue to be) designed by the Moving Pictures Experts Group (MPEG) for digital audio and video. The most current version in wide use today is MPEG 4. Note: MPEG 7 has recently been released – in July 2001 – and MPEG 21 is currently in development. (Emberton, 2001, para. 1)

Features of MPEG 4:

- As a standard which specifies a data model for video and audio compression, MPEG is truly platform independent. In fact, the MPEG 4 standard is expected to be applied to wireless video and handheld applications. (THM, prt. 3)
- Based in the QuickTime format, MPEG 4 goes beyond just compression to include animated sprites and interactivity. (Emberton, 2001, para. 10)
- In addition to high quality video, MPEG 4 provides compressed CD quality audio.
- MPEG 4 compression algorithms work by selecting a series of key frames. Other frames are described according to how much they change between the key frames. (Emberton, 2001, para.7)
- MPEG 4 may well become the standard codec file format in the same way as MP3 did for music (Marioni, 2001, pg. 6)

Features Compared:

	QuickTime	Real Systems	Windows Media
Applications	cd-rom, dvd, kiosk, Internet	Internet only	cd-rom, dvd, kiosk, Internet
Types of video	full download and streaming	streaming only	full download and streaming
Compression Type	lossy	lossy	lossy
Number of video tracks in stream	??	8	5
Number of audio tracks in stream	??	8	1
Number of media formats it can read	at least 50	around 10	around 9
Cost of Player	free	free	free
Cost of Server	free to use	$1995.00	??
Common Platforms	Mac (and Windows)	Mac and Windows	Windows (and Mac)
Additional Server Platforms	Linux, Solaris, and FreeBSD	Linux and Solaris	??
Best Feature	Compatibility/Cost	Streaming Quality	Image Quality

Summary:

Each of the video architectures we have seen has both strengths and weaknesses as developers use it to show video on CD-ROM, DVD, and the Internet. QuickTime, has a long history as a multiplatform and multifunctional performer. It offers developers of CD/DVD and Internet applications full download, and progressive and real time streaming video. Windows Media (Windows Video) offers developers high quality full download or streaming images with or without a dedicated server. Real System is designed for web delivery for streaming video alone, it may do one thing, but, it does that thing well, offering users a range options for ensuring that the quality of the streaming video and audio remain constant in spite of network traffic. The context of all three platforms is likely to change dramatically over the next few years as the latest MPEG

compression formats and algorithms make the codecs that encode the video more standard.

References Used:

Aylward, Darryl (2000) Web Video. *The Documenter* (Vol.3,No. 3). Retrieved on 8/1/2001 from http://www.documenter.com/issue033/033aylwa.htm

Cnet: The Computer Network –Glossary (2001) Retrieved on 8/2/2001 from http://cnet.com/Resources/Info/Glossary/

Codec Central (1): Architectures.(n.d.) Retrieved on 8/1/2001 from http://www.icanstream.tv/CodecCentral/Architectures/index.html

Codec Central(2): Streaming Basics (n.d.) Retrieved on 8/1/2001 from http://www.icanstream.tv/CodecCentral/GenInfo.html

Digital Video -- Architectures: digital video formats. (1997) Retrieved on 8/1/2001from http://www.dartmouth.edu/~cc/didactic/video/about/architectures.html

Emberton, David J. (2001, July 10) Understanding MPEG. Retrieved on 7/30/2001from http://cma.zdnet.com/texis/techinfobase/techinfobase/+9r_eJlwyxzmwwwAqFqr+s8v8WXm7mwwwhnzmwwwwpFqrp1xmwBnLFqnhw5B/display.html

Fischer, Bernd and Udo Schroeder (1999, Sept 24) Digital Video Guide. Retrieved on 7/30/2001from http://www4.tomshardware.com/video/99q3/990924/index.html

Fowler, Jay (1997, Aug. 25) Video Compression: A Codec Primer *Webmonkey* Retrieved on 7/30/2001from http://hotwired.lycos.com/webmonkey/97/34/index1a.html?tw=multimedia

Maroni, Reno (2001,Jan 19) Streaming Video for the Masses.Retrieved on 7/30/2001from http://hotwired.lycos.com/webmonkey/01/03/index4a.html?tw=multimedia

QuickTime 5 Datasheet. (2001) Retrieved on 8/1/2001 from http://a1824.g.akamai.net/7/1824/51/57f4531423b01a/www.apple.com/quicktime/pdf/QuickTime5_DS.pdf

Why RealSystem Producer Plus? (2001) Retrieved on 8/1/2001 from http://www.realnetworks.com/products/producerplus/features.html?src=noref,rnhmpg_062001,rnhmtn,..,rnhmfs,rsmain,rlvid8_062701,gstartd_120100,nosrc,prdctmn_061201,prdcrpl_030201,pdrpftr,pdrpdoc

Windows Media Encoder (2001) Retrieved on 8/1/2001 from http://www.microsoft.com/windows/windowsmedia/en/WM7/encoder.asp

Windows Media Player 7.1 FAQ (2001) Retrieved on 8/1/2001 from
http://www.microsoft.com/windows/windowsmedia/en/software/V7/V7FAQ.asp

Windows Media Video 8 (2001) Retrieved on 8/1/2001 from
http://www.microsoft.com/windows/windowsmedia/en/WM8/video.asp

Additional Links:

http://www.apple.com/quicktime
Apple QuickTime Home Page

http://www.cselt.it/mpeg/
Moving Pictures Expert Group (MPEG) Home Page

http://www.realnetworks.com/products/index.html
Real Networks Digital Media Products Page

http://www.microsoft.com/windows/windowsmedia/EN/default.asp
Windows Media Technologies Home Page

http://www.zdnet.com/products/stories/reviews/0,4161,2625550,00.html
ZDNet's Review of the Three Video Architectures

Author Information:

This paper is written by Karen French
for the course EDC385G Multimedia Authoring at the University of Texas -Austin