Streaming Media,
Changing the Broadcast Paradigm

Bill Swersey

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Abstract

The advent of *streaming media* –the ability to easily transmit audio and video content over the Internet - promises to significantly alter the familiar landscape of broadcasting as it is known the United States, and perhaps the rest of the world as well.

The ease of implementing this technology, coupled with great increases in computer power, improvements in digital compression and rapidly increasing availability of bandwidth on the Internet are leading numerous private and public entities to adopt streaming media technology in order to enhance or in some cases replace existing methods of communicating.

As more and more streaming media content comes on line, corporations and consumers alike are changing their view of this new mode of transmitting what formerly was only available via broadcast television (including cable and closed circuit) and radio. Streaming media has the potential to allow content owners and rights holders to completely reinvent the world that was once exclusively controlled by television and radio broadcasters, opening an almost infinite quantity of programming to users who will have an unprecedented flexibility over when and where they tune in to it.

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Introduction

Since the dawn of the radio era, broadcasting - the ability to reach large audiences with radio or television signals transmitted over a wide area - has generally been the exclusive domain of governments and powerful private entities that owned broadcast transmission infrastructure outright or could afford access to it. Without entrée to the broadcast infrastructure, it was virtually impossible to transmit an audio or video signal to an audience of any significant size.

Assuming that a person, organization, corporation, advertiser or government had such access, they were only ensured of reaching the audience within the "footprint" of the broadcast signal (or cable or satellite television system audience) and then only reaching the people who were actually tuned to that frequency at the time the signal was being transmitted. Under the system that existed in the United States and many other countries since the first broadcasts, frequencies were limited and controlled and an insignificant number of common people have ever been able to employ broadcasting technology to communicate on a personal level.

At present we are living through a period when this paradigm is changing rapidly. The development of streaming media technology is dramatically altering the traditional notion of "broadcasting," in all likelihood forever. The widespread implementation of computer-based streaming audio and video is already having a profound impact on the way such media are conceived, delivered and consumed.

This paper will discuss the various factors that have directly and indirectly led to the rapid proliferation of streaming audio and video on the Internet, including the evolution

of the technology necessary to support large scale implementation of streaming media, the major technology platforms currently in use and the development of Internet protocols that specifically improve the quality and performance of streaming media.

In addition, this paper will present an overview of the future of streaming, covering some of the areas where streaming media seems poised to make significant impact, competing with and even surpassing traditional broadcast television and radio.

Chapter 1 – Paradigm Shift

The ability to bypass the traditional broadcast architecture to deliver audio and video programming over the rapidly developing IP network infrastructure has, in just a few years, opened vast amounts of content to a worldwide audience and empowered individuals and interest groups who just a few years ago had no chance to employ such communication tools. From news and business messages to education and certainly entertainment programming, the ability to "stream" rich media content in real-time, from one relatively inexpensive computer to another or even to millions simultaneously, without employing transmission towers, is changing the way we communicate.

The sea changes taking place as more and more audio and video content is transmitted over IP networks, point to a significantly altered world of audio, video and the still-developing category of other "rich media" content in the future and quite possibly a world where the large broadcasting companies who have dominated radio and television since these media were introduced will see their influence diminish as technology lowers the barriers to entry.

In less than ten years, the notion that individual users could have access to thousands or even millions of audio and video assets "on-demand" and would be able to "tune-in" to live or archived programming using a desktop computer or even a special streaming media device connected to an IP network connection, has gone from fantasy to reality for most computer users in the United States. A survey published by computer research firm Media Metrix in January 2001 indicated that some type of streaming media player was

installed on 99% of US home personal computers and nearly 50% had used at least one such player at home in the last month of the survey.[1]

Huge bodies of content are being digitized and archived for on-demand access and terms like "webcast" have entered our lexicon. A multi-billion dollar industry has been created around streaming media services and software products such as Real Player are now a familiar part of most users' everyday computing environment. The recent television commercial where a man checking into a motel is told that all rooms have "every movie ever made, in any language, any time day or night,[2]" seems less like science fiction than it did just a few years ago.

Radio Resurgence

The rapid spread of this nascent technology has significant ramifications for both traditional and fledgling broadcasters as long established usage patterns and perceptions of media are beginning to change. Until recently, for example, radio broadcasts were generally lost after their initial airing. Even if recorded, they were not readily available to anyone wishing to listen after the fact. Today, National Public Radio archives nearly all its daily programming on its website, even offering searchable indexes for easier access. Moreover, streaming media is leading to a resurgence of interest in radio since any computer is now a potential radio transmitter.

One aggregator of online radio content, live365.com**,** hosts more than 35,000 different radio programs delivered in streaming MP3 format, offering something for nearly everyone from pop to obscure ethnic music, talk, comedy and even children's

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[1] 2000 Media Player Focus Report, *Media Metrix* , January 22, 2001, http://us.mediametrix.com/press/releases/20010122.jsp

nursery rhymes. In addition to allowing any individual a place to originate their streaming broadcasts (in return for the right to insert advertising at pre-determined intervals), the site provides commercial-free hosting services for a monthly fee in order to "provide a podium and a microphone to tens of thousands of organizations that would not normally be able to afford broadcasting solutions."[3] It seems inevitable that changes such as this will cause the media consuming public to have less regard for traditional broadcast schedules.

Accessibility

Not only is streaming media affecting the mechanism of broadcasting, but the messages put forth are changing as well as formerly impenetrable barriers fall. Few non-professionals other than perhaps amateur ham radio operators could dream of sending their voice or message around the world until very, very recently. Suddenly, anyone with inexpensive, off-the-shelf equipment and a message to share, be it political, artistic or totally frivolous, can reach a worldwide audience with relative ease. The opposition movement fighting the Russian Army in the republic of Chechnya makes clever, if not ominous use of streaming media on their website, Kavkaz Center, reinforcing their view of the conflict with numerous streaming video files, including some which show horrific surprise attacks where Chechen guerillas kill dozens of Russian soldiers.[4]

But it is not just individuals or political outsiders who are empowered by streaming media. The proliferation of streaming media is showing a very significant potential to change corporate communication, allowing companies a new level of control over the

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[2] *Quest* commercial, http://www.adcritic.com/content/qwest-every-movie.html

messages they present to their consumers, shareholders and even their own employees. Large enterprises such as the Boeing Corporation, with a disparate client base, numerous manufacturing facilities, large suppliers network and of course, tens of thousands of investors spread around the world, are aggressively employing streaming media as part of a strategy to take control of their communications in a way never before possible. Rather than being at the mercy of television and radio networks, companies are creating their own "channels" and taking control of distribution over the Internet in order to webcast new product announcements, annual shareholder's meetings and bring corporate training directly to the desktop of every employee worldwide.

Since the passage of Regulation FD (Fair Disclosure) by the United State Securities and Exchange Commission in August 2000,[5] public companies have been required to make important information available to all investors, not just Wall Street insiders. One way these companies have moved to comply with this regulation has been to employ inexpensive streaming media technology to open to the public the conference calls they regularly hold with Wall St. analysts. It is now possible for hundreds, or even thousands of interested investors to sit in on an investor conference call on the Internet, in fact more than 17,000 listeners tuned in to a recent webcast call by computer storage manufacturer EMC.[6]

It seems inevitable that large companies such as Coca-Cola, General Motors, Gap, and Sony will use streaming media technology to become broadcasters in their own right,

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[3] Broadcast365 - Basic Service Package description
http://www.live365.com/plr/order.live?level=Basic
[4] Kavkaz Center, Video archive, http://www.kavkaz.org/english/media/video.htm
[5] Commission Votes to End Selective Disclosure, *SEC news release*, August 10, 2000,
http://www.sec.gov/news/extra/endseldi.htm
[6] In Praise of Regulation Fair Disclosure, by Amey Stone, *Business Week,* April 26, 2001,

in the not too distant future, creating and controlling audio, video and other multimedia programming and delivering it directly to whatever audience they are trying to reach. An example of this trend is clearly visible on Anheuser-Busch's Budweiser Beer website[7] which features streaming pop music on “Bud Radio” as well as “Bud Vision,” an area where users can replay Budweiser television commercials, other so-called “web-exclusive” video content, and connect to live webcasts on occasion. For innumerable smaller companies, streaming media levels the playing field, providing an opportunity to try to build a worldwide brand at a fraction of the cost of utilizing traditional broadcasting.

Quality

Despite increasing popularity, the perception among many Internet users is that streaming video is at best a novelty: fuzzy, stuttering pictures delivered into a tiny window on a computer screen, slow to start playing and subject to frequent pauses. Certainly the first versions of streaming that many saw 3 to 5 years ago were poor quality, but rapid advances in compression technology and the power of computers and, of course, significant increases in the amount of bandwidth now available to home and business users are fast making streaming over IP a viable method of delivering broadcast-quality (and soon even better) video, bypassing broadcast, cable and satellite television providers entirely.

Like many other modern technologies, the evolution of streaming media is occurring at a blistering pace. The sophisticated codecs (compression/decompression algorithms at

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http://www.businessweek.com/technology/content/apr2001/tc20010426_035.htm

[7] *Budweiser* Beer Website, www.budweiser.com

the heart of all digital streaming systems) available to consumers have come a long way since RealNetwork's Real Audio player was introduced in 1994. Today, excellent, near-CD quality audio is widely available, through a 128kbps stream. In fact, the current generation of PC-based software players are easily able to keep pace with a 500kbps stream, for "near VHS" quality video through a broadband (LAN, DSL and Cable Modem) Internet connection; the next generation promise better than VHS quality, approaching clarity and detail only available on DVD.

A number of recent streaming media presentations clearly show that the technology is moving forward at a remarkable pace. A trailer for the film Jurassic Park III, presented in the spring of 2001 on Apple Computer's QuickTime website[8], automatically sets a user's computer to standard TV resolution (640 x 480 pixels) and proceeds to stream a video clip of remarkable picture and sound quality. The 2 minute 20 second clip is also astoundingly large, weighing in at more than 47 megabytes, and requires both a very fast computer and a very fast Internet connection. Nevertheless, as a demonstration of what is possible, it is quite convincing.

Similarly, Microsoft's very high bandwidth (700 kbps) presentation of a November 2000 London concert by pop star Madonna[9] presented in Windows Media format, can certainly be considered near-VHS quality, especially when viewed on a computer monitor set to television screen resolution, though Microsoft's claim that the quality is "near-DVD" can only be viewed as overzealous marketing hype[10]. Still, after seeing

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[8] Jurassic Park III trailer, http://www.apple.com/trailers/universal/jurassic_park_3/index.html
[9] http://212.162.58.4/asx/msn/madonna700.asx
[10] Madonna Webcast shows Internet is not TV, Gwendolin Mariano, *CNET News.com*, http://news.cnet.com/news/0-1005-200-3890055.html?tag=prntfr

either of these examples, it is hard to remain unconvinced about the ability of streaming media to directly compete with broadcast television on quality..

Chapter 2 – Why Now?

Three Key Factors

While streaming media existed before the Internet explosion of the second half of the 1990s in limited teleconferencing and closed circuit broadcasting implementations, it began to blossom about the same time the Internet started to become a part of most American's daily world for the same reasons that made the Internet revolution possible. Simply put, to be able to experience streaming media today, a user must have three key components:

1. A ***computer*** of sufficient processing power to process (decompress) a data stream containing audio or video content in real-time. The computer must have a recent generation CPU as well as sufficient hard disk space and internal memory to store the required software and allow temporary storage (buffering) of the incoming data stream.
2. ***Software*** (generally a "player") installed on the computer to work with the compression/decompression algorithms (CODECS) that transform audio and/or video content from a compressed digital data stream into an audio and/or video presentation, and vice versa.
3. A **connection** to an IP network of sufficient capacity to sustain a connection between the user's computer and the server from which the streaming content data stream is originating.

The absence of any one of these elements eliminates the possibility of receiving streaming content.

Before a certain point in time, sometime around 1994, none of these elements were available to the public. Personal computers had evolved to the point where they were powerful enough to support a graphical user interface and were fine for word processing, spreadsheets, and even playing a rudimentary multimedia CD-ROM, but few had sufficient processing power, hard disk storage space or internal memory to receive a real-

time flow of multimedia data over a network and instantly transform it into decent quality audio or video. The necessary codecs were not available to consumers and the average modem connection was certainly too slow to support even rudimentary streaming audio content.

To digitally record audio generally requires sampling at a rate between 11 and 44 kHz; in order to transform sound to the "ones and zeros" of digital code so that it can be played back smoothly; one second of sound must be broken into many thousands of discrete samples. While a sampling rate of more than 44,000 samples per second does not yield any audible improvement in quality, most people will notice that audio sampled at less than 11,000 Hz is diminished by distortion and digital artifacts. Playing digital audio on a computer (streaming or not) requires converting this information from digital to analog form at the rate it was encoded, but this task does not require terrific computing muscle and computers have had sufficient power to do so for quite some time (an audio compact disk player is a basic digital to audio converter).

The eye can be more easily "fooled" than the ear; rather than the thousands of samples per second needed to digitally record sound, pictures changing at the rate of 12-15 frames per second (fps) can acceptably replicate video animation (although 24-30 fps is considered ideal), a frame rate of more than 30 fps is unnecessary. Digitizing video at this rate is not difficult but decoding and displaying such information any larger than a postage stamp in real time has until recently been quite difficult for all but the most powerful computers.

Computing Power

Over the past decade, as computers have become more powerful, video compression techniques and codecs have advanced significantly to the point where it is possible to show some representation of video at low resolution (in a small window) over a 56k modem connection, but the amount of processing power required to decompress and display high frame rate digital video at a resolution approaching that of television is still a difficult task.

The challenge lies in the need to decompress and display the information using a computer's video display system. As incoming data is processed by the computer, each individual frame of video must be displayed for a brief moment and then without apparent delay, a subsequent frame must be posted and so on. In one frame of 640 x 480 video there are more than 300,000 unique pixels, each of which may be one of thousands or even millions of shades of color and intensity. Data compression can reduce the actual number of unique pixels that need to be displayed, but even 10% of 300,000, at a frame rate of 15 fps, would require the display of nearly one half million pixels every second. Consumer-level computers have only been powerful enough to comfortably handle such data throughput for a few years now.

Bandwidth

Which came first, the modem or the content? Until the mid-90s, few computer users owned modems that were useful for transferring anything other than text and small graphics files, but there wasn't much else to transfer. The original V.34 standard, which was finalized in the spring of 1995, allowed for speeds of up to 28.8 kbps. An improved version of the V.34 standard, finalized in the fall of 1996, increased the speeds to 31.2

kbps and 33.6 kbps[11]. Only at these connection rates did browsing the graphically-rich Internet become even marginally practical, yet the only streaming content tolerable to most users at 33.6 kbps is modest quality audio. The current standard telephone dial-up modem protocol V.90, which supports connection speeds of up to 56.6 kbps, was defined in February 1998 by the International Telecommunication Union (ITU) Telecommunication Standardization Sector. At 56.6 kbps, reasonable quality audio and some representative video (at low resolution and very modest frame rates) is possible.[12] Since 1998, the amount of streaming content available on the Internet has increased by several orders of magnitude. There is no escaping the conclusion that the availability of inexpensive 33.6 kbps and 56.6 kbps modems presaged the rapid increase in awareness and popularity of the Internet as a mainstream communication medium.

Yet today, for the overwhelming majority of home Internet users who connect using a dial-up modem, the Internet is a decidedly low-bandwidth experience. According to a recent Media Metrix report, at the end of the first quarter of 2000, 68.1% of U.S. Home Internet Users with Modem Enabled PCs connected at 56.6 kbps and 27.1% were connecting at 33.6 or less. The same report counted only 4.8% of U.S. homes utilizing ISDN, Cable Modem or DSL (digital subscriber line) technology to connect to the Internet at 128k/sec or faster.[13]

The cable television industry and local telephone companies are aggressively moving to offer high-speed cable modem and DSL service to their customers and this past year large numbers of homes have signed up for broadband Internet service. A study

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[11] Curt's High Speed Modem Page, http://www.teleport.com/~curt/modems.html
[12] The ITU Telecommunication Standardization Sector, http://www.itu.int/ITU-T/
[13] Toward Faster Internet Access, Richard Santalesa, *ZDNet*, http://www.zdnet.com/zdhelp/stories/main/0,5594,2570300,00.html

published on March 1, 2001 by research firm Kinetic Strategies Inc., counted 6.6 million households in the US and Canada subscribing to broadband services at the end of 2000: 4.8 million with cable modems and 1.8 million using DSL. Kinetic reported that cable MSOs added 3 million cable modem subscribers in 2000 and estimated that by March 2001, the number of broadband subscribers in North America had grown to 7.8 million; a growth rate of more than 18% in just the first 2 months of the new year.[14] As awareness of broadband service increases the number of homes with such connections can be expected to continue to rise rapidly.

Software

The final part of the streaming puzzle, after sufficiently powerful computers and adequate bandwidth, is the streaming software systems that actually bring a data stream to life. The introduction of Real Networks "RealAudio" streaming audio codecs, player and server architecture in 1994 can arguably be considered the dawn of the streaming media age. Up until that point, some audio and some animation and video files such as ".wav," ".avi," and QuickTime were available over IP network connections, but almost without exception the files had to be completely downloaded and then played. Real-time playback of streaming media was impossible until codecs evolved to a point where they could work on an "off the shelf" home computer, keeping up with the continuous data stream. Today three powerful rivals are battling for dominance in the streaming software market: RealNetworks, Apple Computer and of course Microsoft.

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[14] Cable Continues to Dominate DSL in Residential Broadband Market, Kinetic Strategies, March 1, 2001, http://www.kineticstrategies.com/ksi_release_3-1-01.html

While the three aforementioned factors have been of paramount importance in the evolution of streaming media to present, other elements have played roles that cannot be overlooked including the growth of the nationwide Internet infrastructure, advances in server technology and architecture, and the development of protocols specifically designed to facilitate efficient transport of streaming media content on the packet switched network.

Chapter 3 – Format Wars

Although most users never even think about the difficulty, delivering streaming media is a completely different and much more demanding task than serving the static text and graphics that make up most web pages. The Internet infrastructure was initially built to carry text and graphics data and the protocols that early on became standards reflect those needs, not the need to transport continuous time-based media. Whereas the primary criteria in simple (non-time-based) data transfer is reliability and speed – ensuring that all packets get to their destination as quickly as possible – the critical concern with time-based media is ensuring that the packets arrive in a continuous sequence so they can be played back in the intended order without noticeable interruption.[15] If, somewhere between the sending computer and the receiving computer, a packet of text data is lost and needs to be resent, it can be placed where it belongs after it arrives. On the other hand, if a streaming audio or video packet needs to be resent, it may arrive after other packets in the sequence have already been played.

Streaming Protocol

Given that the Internet was originally conceived to facilitate the transfer of text and graphics files and that TCP/IP protocol is not suited for multimedia traffic, other protocols had to be developed to better support a growing supply of and demand for multimedia content. The use of Real Time Streaming Protocol (RTSP) and User Datagram Protocol (UDP) protocols, coupled with significant increases in available bandwidth and of course the evolution of the personal computer platform and

compression technologies, have led to significant improvements in the quality of streaming media content and the overall streaming media experience for consumers in recent years.

To better understand the role that these protocols have played, it is helpful to examine how content delivery works on the Internet. Data delivered from a web server via Hypertext Transfer Protocol (HTTP) requires a connection only for the amount of time it takes to deliver the data from the server to the client computer, whereas a true streaming connection must be maintained for the entire duration of a presentation. Furthermore, not only must that connection be maintained, but ideally the client and server should be able to coordinate resending lost data packets and adjustment of the data rate in accordance with changes in the quality of the connection they are working with.

The wild growth of the World Wide Web is due in large part to the success of the standard Hypertext Transport Protocol (HTTP). The common language that allows web servers and web browsers to communicate simply and efficiently, HTTP is a layer on top of the Transmissions Control Protocol (TCP) which handles all data transfers on the packet switched Internet network. TCP, first used on the ARPANET in the early 1970s[16], was developed for tasks such as ordinary file transfer and remote log in. TCP has evolved to assure reliability at almost all costs: its highest priority is to deliver 100% of data packets sent from server to client. TCP's built-in flow control mechanism reduces the data rate of a transfer as bandwidth narrows without regard for the type of content being transferred or timeliness. TCP also does not provide for random access to files, required for time-based seeking, and cannot support multicasting (sending one stream to

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[15] RTP/RTSP, Dave Reichmuth & Nan Zhou, March 13, 2001: http://www.sims.berkeley.edu/~zhounan/proj

many users simultaneously). These characteristics make TCP particularly unsuitable for streaming real-time multimedia, thus the need for specialized streaming protocols.

It is possible to serve multimedia content using HTTP/TCP, albeit with limitations. A person wishing to add a bit of audio or a short video clip to their Internet home page can simply encode the content, post it in a directory on an ordinary web server and add a reference hyperlink to a web page. A user who wants to retrieve and play the file will have little problem doing so (assuming their computer hardware and software is properly configured), but this cannot be considered "streaming." What is actually occurring in this scenario is that the file is downloaded and played back; two unrelated actions. If the available bandwidth is greater than the data rate of the file, the user's computer will likely be able to start playing the file before it has finished downloading. This process is sometimes known as "progressive downloading" or "pseudo-streaming."[17] If the data rate of the file is greater than the available bandwidth, the user will experience choppy, stuttering playback accompanied by maddening "rebuffering due to network congestion" messages on their media player. HTTP serving may be acceptable for short, low bandwidth video clips or audio samples, but it is not sufficient for longer, high-quality broadcasts or for situations where more than a small number of users will connect to the server simultaneously, and is impossible to employ for webcasting live events.

Specialized streaming protocols, such as User Datagram Protocol (UDP) and Real Time Streaming Protocol (RTSP) do a much better job of ensuring the high quality delivery of streaming multimedia content because they are oriented toward sustaining a data stream, rather than trying to assure that 100% of data sent reaches it destination.

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[16] Networks in Action, Peter G. W. Keen, J. Michael Cummins, Wadsworth 1994 p. 254

Streaming protocols "understand" that a few lost packets will not compromise real-time audio and video, and so such losses are tolerated. Also, in the hierarchy of Internet protocols, streaming traffic gets higher priority than ordinary TCP traffic, due to the "back -off" policies that are part of TCP. [18]

Streaming media requires a sustained connection. To deliver content in real-time, the rate of data transfer cannot fall below the rate that is necessary for playback, with the exception of a occasional, brief lapse in the data stream which all major streaming systems tolerate by "buffering" or storing some data prior to playback. One of the realities of delivering content over the Internet is the inconsistency of the network's performance. The diameter of the Internet pipe can fluctuate from minute to minute; there is no assurance that the amount of bandwidth ideally desired to deliver a streaming presentation will be available from start to finish. The successful delivery of streaming media in this uncertain environment requires tools that can dynamically adjust to network conditions.

The newest generation of streaming server-client software takes full advantage of streaming protocols, constantly monitoring the quality of a streaming transmission and reducing the frame rate of the video stream, assigning priority to the audio stream, degrading the quality of the audio stream or even pausing the video temporarily in order to insure that the presentation continues to playback in real-time. When the quality of the network connection improves, the presentation quality can be restored to its original desired level.

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[17] Streaming Media World, Synchronized Multimedia Tutorials
http://streamingmediaworld.com/symm/tutor/real1/index3.html
[18] Streaming Methods: Web Server vs. Streaming Media Server, Microsoft Corp.,
http://www.microsoft.com/ntserver/mediaserv/exec/comparison/WebServVStreamServ.asp

RTSP, a proposed standard first published in April 1998 by The Internet Engineering Task Force, a group led by Netscape, Real Networks and Columbia University, is a protocol with syntax and operations similar to HTTP, but specifically designed to facilitate audio and video transport.[19] A key difference between HTTP and RTSP is that the specialized streaming protocol contains a provision for "state" such as "ready" or "pause." HTTP is considered "stateless," once the process is initiated, an http server will attempt to deliver an http request without regard for the readiness of the client. When a client makes an RTSP request, the server does not begin transmission until it receives confirmation that the client is "ready," for example the necessary software has been loaded and memory is available to buffer part of the stream. Furthermore, unlike HTTP, which basically follows an asymmetric process where the client issues requests and the server responds, RTSP servers and clients can both issue requests. For example, the server can issue a request to set playback parameters for a stream.[20]

RTSP and the similar UDP allow client software to incorporate VCR-like controls to regulate viewing of the stream. When a user selects "pause" the server must stop sending data additional packets until the "pause" state is changed to "ready." Additionally, RTSP and UDP provide for monitoring of the quality and condition of the network while a streaming presentation is being served, enabling server and client to work together to adjust a stream according to changing network conditions. By comparison, streaming media served via HTTP persists without regard for the user's ability to process it and

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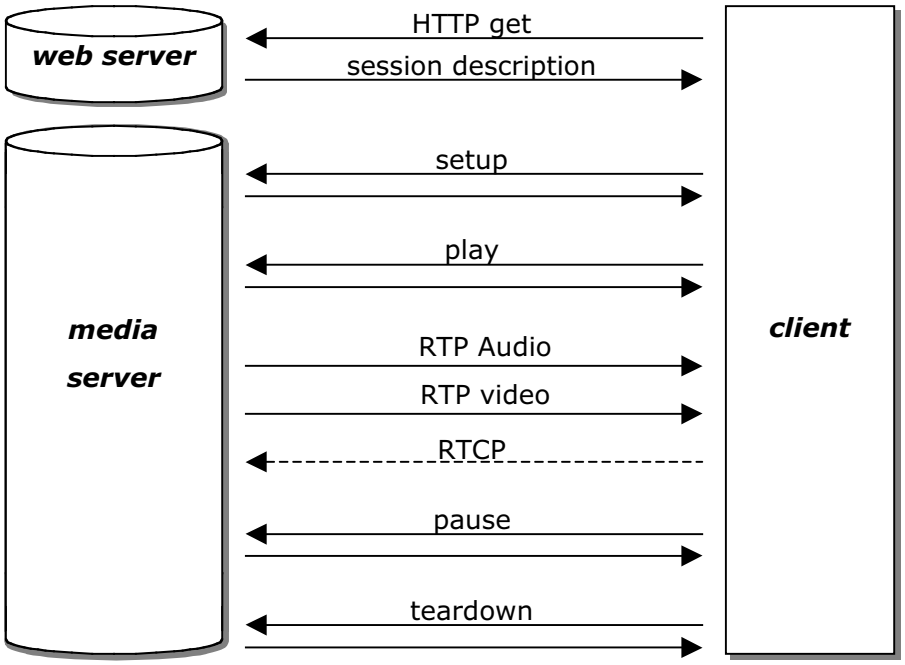
[19] Real Time Streaming Protocol, Schulzrinne, et. al. April 1998 http://www.normos.org/rfc/rfc2326.txt

[20] Multimedia Over IP: RSVP, RTP, RTCP, RTSP, Chunlei Lium, http://www.cis.ohio-state.edu/~cliu/ipmultimedia/

cannot be adjusted to compensate for degradations or improvements in network conditions.

Typical RTSP operation[21]



[21] RTSP Overview, Henning Schulzrinne, http://www.cs.columbia.edu/~hgs/rtsp/talk/talk1.html

Presently, three large companies are battling to have their product become the dominant streaming media format employed by web developers to present streaming audio and video: *RealNetworks'* "RealSystem" which includes the RealPlayer client application and the RealServer delivery platform, *Microsoft's* "Windows Media Technologies" player, encoder and servers and *Apple Computer's* "QuickTime" player and server.

There are various technical differences between these product suites and how they approach the task of delivering streaming media, but perhaps the more interesting difference is the varied business approaches that these corporations have taken toward streaming media.

RealNetworks

RealNetworks, the only "pure play" streaming media company among the three main combatants, was founded in 1994 specifically to sell their proprietary streaming audio solution "RealAudio." One key business strategy that sets Real apart from either Apple or Microsoft is the business model the company has stood by from the very beginning: to derive revenue by licensing their server technology based on the number of concurrent "streams" it can deliver. RealNetworks software to serve 100 simultaneous users currently sells for nearly $6000 (without authentication and advertising insertion capability which can easily double the price).[22] Over the past few years Real has also aggressively marketed the company brand and signed partnership agreements in an attempt to get consumers to regard "Real" as synonymous with both streaming media

technology and *content*. The Real.com website is now among the most visited portals for streaming content (all served in Real format) and as of April 2001 the company claimed to have more than 200 million unique registered users of its RealPlayer software worldwide and more than 200,000 subscribers to its $9.95/month "Gold Pass" service,[23] which include the "premium" version of its player software and exclusive access to streaming entertainment and sports content unavailable to non-subscribers. The seemingly never-ending stream of marketing hype does seem to be paying a dividend, as a recent Neilsen//NetRatings study reported "home consumption of Internet audio and video content in the Real format reached an all time high in February 2001—more than double that of its nearest competitor."[24]

While RealNetworks does seem to own the lion's share of the streaming market at the moment, Microsoft and Apple have ceded nothing in this race. Since the early 1990s, Apple has installed its QuickTime player on all Macintosh computers sold (it is available as a free download for users of the Windows operating system), and currently bundles the QuickTime Streaming Server software with its Mac OS X Server package, a combination that can support more than 2000 concurrent streams.

Windows Media

Windows Media Player is positioned by Microsoft as an integral part of its Windows operating system (it is available as a free download for Macintosh users), and Windows Media Services streaming functionality is built directly into Microsoft's Windows 2000

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[22] RealSystem Server Professional price list, RealNetworks.com, http://www.realnetworks.com/products/servers/internet/index.html?src=r-prognet.nosrc.prdctmn_041301.ra8smsk_040201.dlvrit

[23] RealPlayer Surpasses 200 Million Unique Registered Users, *RealNetworks press release*, April 12, 2001, http://www.realnetworks.com/company/pressroom/pr/2001/200m.html

Server with no additional hardware, software or per-stream licensing fee necessary for usage. Microsoft claims that an independent test verified the ability to sustain more than 9,000 concurrent narrowband streams on a single server, leading the company to boast that "the average implementation cost of Windows Media is half that of solutions based on competitive platforms."[25]

QuickTime

Apple's QuickTime, introduced in May 1991 for use with multimedia CD-ROMs, is viewed by many as the technology that first enabled personal computers to playback synchronized, time-based video and sound. Today QuickTime is highly regarded by film aficionados for the excellent quality video it delivers (in both true streaming and pseudo/downloadable form) and the simplicity of its user interface. However, it still lags way behind RealPlayer Windows Media Player in total installations. A Jupiter Media Metrix study released in April 2001, reported that fewer than 10% of all home Internet users in the US used QuickTime software to view streaming media in January 2001.[26]

Many industry experts blame Apple for never adequately promoting QuickTime technology; the company has appeared over the years to view the product more as an opportunity to showcase Apple's reputation as a technology innovator than as the preferred streaming media format. To that end Apple has integrated QuickTime into the Apple Macintosh Operating system, much in the same way that Microsoft has built Windows Media around the Windows OS. While Apple supports the approximately 90%

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[24] RealNetworks Extends Format and Usage Leads to All-Time Highs, *Real Networks press release,* http://www.realnetworks.com/company/pressroom/pr/2001/usage_leads.html
[25] Windows Media Technologies, *Microsoft Corporation*, http://www.microsoft.com/windows/windowsmedia/en/technologies/services.asp

of the computing universe that uses computers running Windows with a full featured version of their QuickTime player software, the QuickTime Streaming Server only runs on Macintosh servers.

Over its lifetime, QuickTime has developed steadily. The most recent release, version 5, made available without charge in May 2001, sports an elegant interface, improved streaming and the latest revision of the much-heralded Sorensen video codec. Still, Apple has never committed the marketing budget and resources to QuickTime that might enable it to compete with the massive effort Microsoft and Real have thrown behind their products. Apple's primary goal has always been to sell computers and QuickTime is apparently seen as a means to that end. Ultimately, the association with Apple Computers, despite the QuickTime Player's full compatibility with PCs running windows, may be its biggest liability when trying to win over consumers.

In the long run, the bitter war between RealNetworks, Microsoft and Apple and the lack of a common standard format for steaming media content may turn out to be a handicap in the evolution of the medium itself. QuickTime, Real and WMP can all play many formats, but none can play the proprietary formats developed by any of the other two (with the exception of minor deals between Real and Apple to deliver some versions of QuickTime from its servers and RealPlayer's ability to decode an old version of Windows Media audio), thus consumers must bend over backwards to install more than one, and in many cases all three of the software players in order to receive the full range of content available on the Internet. Content producers are forced to publish the exact same content in multiple formats if they wish to reach the maximum possible audience.

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[26] Users of Media Player Applications Increased 33 Percent Since Last Year, *Jupiter Media Metrix,* http://www.jup.com/company/pressrelease.jsp?doc=pr010403

Standards

MP3

The huge popularity of the MP3-audio format (both streaming and non-streaming), which all three streaming players and numerous others can play back, is an example of what can happen if a standard, either *de facto* or *de jure*, is embraced by producers and consumers. In just a few years, MP3 has become ubiquitous; it is almost becoming less and less common to find any audio, particularly music, on the Internet today that is offered in a proprietary format.

MPEG-4

The most recent proposed standard from the Moving Picture Experts Group, MPEG-4, has the potential to bring all digital audio and video in line, much in the same way that MPEG-2 has done for digital television and DVD players and the JPEG standard did for digital photography files and MP-3 audio format, actually a part of the MPEG-2 format, has done for audio. Finalized in October 1998 and adopted as an ISO/IEC standard in early 1999, MPEG-4 reaches beyond audio and video to include interactivity and relationships between objects in time in a multimedia presentation as well as distribution of and access to interactive multimedia content on the World Wide Web.

As set out in the MPEG-4 proposal, the standard seeks to address key issues for a number of different groups involved with multimedia:

> • For authors, MPEG-4 enables the production of content that has far greater reusability, has greater flexibility than is possible today with individual technologies such as digital television, animated graphics, World Wide Web

(WWW) pages and their extensions. Also, it is now possible to better manage and protect content owner rights.[27]

• For network service providers MPEG-4 offers transparent information, which can be interpreted and translated into the appropriate native signaling messages of each network with the help of relevant standards bodies.

• For end users, MPEG-4 brings higher levels of interaction with content, within the limits set by the author. It also brings multimedia to new networks, including those employing relatively low bitrate, and mobile ones. An MPEG-4 applications document exists on the MPEG Home page, which describes many end user applications, including interactive multimedia broadcast and mobile communications.

For all parties involved, MPEG seeks to avoid a multitude of proprietary, non-interworking formats and players.[28]

The video element in MPEG-4 was loosely modeled after Apple's QuickTime technology, a vindication of sorts for Apple, but a likely sore point for RealNetworks and Microsoft. The standard accommodates bitrates from 5 kbps to 10 Mbit/s and incorporates advanced compression to increase efficiency and quality at all bits rates covered.[29]

The promise of a media standard that might be able to streamline distribution of interactive media from one server to the Internet, digital television set-top boxes, cell phones, PDAs and other devices, while solving problems such as digital rights management, sounds too good to be true given today's acrimonious business climate. On the other hand, it is quite sobering to look toward a future with an even more complex and chaotic media landscape and no cooperation between the major producers, distributors and consumers.

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[27] The MPEG-4 format contains specific provisions for digital rights management, an area of growing important for copyright holders in the digital age.
[28] Overview of the MPEG-4 Standard, Rob Koenen, Editor
http://www.cselt.it/mpeg/standards/mpeg-4/mpeg-4.htm
[29] The MPEG-4 Standard, *ZDNet Developer*,
http://www.zdnet.com/devhead/stories/articles/0,4413,2667085,00.html

Even if MPEG-4 is supported, it is not clear if the standard will hold together under the intense competitive pressure likely to exist in the media business in the future. The very real possibility exists that companies will pick apart the standard, using bits and pieces as they see fit, while promoting their own proprietary solutions.

Another view of standards is that once adopted, they relieve companies of the burden of competing with one another on a wasteful grand level. Interoperability benefits content providers who can spend time and money on content rather than encoding and consumers who don't need to be concerned with having all possible technologies. Tim Schaaff, of Apple's QuickTime engineering team feels strongly that standards benefit the companies providing the technology, "Adopting standards allows companies to develop in the area of their expertise. The competition becomes purer and cleaner. You're competing on implementation, not on file format."[30] This view is not surprising coming from Apple; as might be expected, RealNetworks and Microsoft have to this point been very cautious in their public comments about MPEG-4 considering the potential loss of revenue and pride that the widespread adoption of such a standard could bring.

The establishment in late 2000 of the Internet Streaming Media Alliance (ISMA), whose charter members include: Apple Computer, Cisco, IBM, National Semiconductor, Philips and Sun Microsystems adds another element to the streaming media standards conflict. ISMA's website, www.isma.tv, states that the group was formed "to provide a forum for the creation of specification(s) that define an interoperable implementation for streaming rich media (video, audio and associated data) over Internet Protocol (IP) networks…[and] also provide a forum for the creation and sponsorship of market and

[30] Navigating the MPEG-4 Labyrinth, Stephen Jacobs, *Streaming Media Magazine* , May/June 2001, pp.42.

user education programs to accelerate the demand for products based on these specification(s)." Lofty goals, but without the participation of RealNetworks and Microsoft what chance do they have of success?

Other Approaches

Even as the streaming media industry discusses standards like MPEG-4, others are taking a completely different approach, for example several companies are demonstrating sophisticated yet lightweight Java applets that can load just ahead of streaming audio or video content in any modern web browser and decompress video without needing any additional plug-ins or player applications. Vancouver, B.C.-based Destiny Media Technologies has received much attention since unveiling its impressive "Clipstream" audio and video player, a tiny Java applet that approaches the performance and quality of the major streaming media players. Destiny claims Clipstream, which is platform independent, can reach more than 92% of all Internet users.[31] The fact that there is no large player application to download and install is extremely convenient for consumers and allows for easy updating as the technology evolves.

It is impossible to tell at this point which of these approaches will prevail, there are too many known and unknown variables. As long as Microsoft, RealNetworks and Apple are making money and/or realizing other business objectives with their streaming products, there is little reason to abandon them. Perhaps it will take a generational shift, such as the move to wireless devices, before a truly new way of preparing and delivering streaming media is implemented.

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[31] VideoClipstream, Destiny Media Technologies, Inc., http://www.videoclipstream.com/

Chapter 4 – Case Study: Boeing

The Boeing Company is the largest aerospace company in the world and one of the largest commercial entities in the United States with revenues in fiscal year 2000 of $51.32 billion[32]. Their communications needs are huge, with some 200,000 employees at numerous manufacturing facilities, a vast maintenance and suppliers' network, customers of commercial and military aircraft, missiles, space and communications products and innumerable shareholders spread around the world.

Boeing has been a leader in the implementation of streaming media, particularly video, to meet some of these needs. Boeing first experimented with streaming media in 1996, using RealAudio from their Seattle, Washington neighbor, RealNetworks.

"Large Pipes"

From the start, the company was in a unique position to add streaming media, particularly video, to their IP network, due to the significant network architecture already in place to support heavy traffic of engineering data between design, manufacturing and maintenance facilities around the world. These "large pipes" had excess capacity that could be utilized by streaming media content for various purposes.[33] Today Boeing uses streaming media in three forums: public Internet, company intranet and an extranet that is used by customers and vendors.

The streaming media accessible to the public on the Internet is mostly carefully edited marketing presentations that demonstrate various Boeing products, including

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[32] Profile - Boeing Company, Yahoo Finance, http://biz.yahoo.com/p/b/ba.html
[33] "Jet Streaming", Max Bloom, *Streaming Media magazine*, March 2001, p.27

commercial and military aircraft, the Sea Launch ocean rocket launch platform and the International Space Station. These on-demand videos are presented in RealVideo in three bandwidths: 20 kpbs for 28.8 kpbs modems, 34 kbps for 56 kbps modems and 200 kbps for faster Internet connections.

Webcasts

In addition, the company uses live streaming video "webcasts" to draw attention to test flights and other milestones involving major products or projects. On August 2, 1998, the first flight of a new Boeing jetliner model, the 757-300[34], was shown live on the Boeing home page. An edited archive version of the event was then made available on the public Internet page Boeing maintains for the 757-300 project. Since the 757 test flight, Boeing has presented live streaming webcasts of the first flight of the 717-200 jetliner[35] in September 1998, as well as the October 9, 1999 inaugural commercial rocket launch from the floating *Sea Launch* platform, 1500 miles southeast of Hawaii in the Pacific Ocean.[36] The recent announcement that Boeing plans to develop a new generation of faster flying, nearly-supersonic passenger aircraft was also webcast.[37]

Like many other companies, Boeing now regularly produces webcasts of annual shareholders meetings and other major corporate announcements.[38] In order to reach the largest audience of shareholders, some of these webcasts are offered in Microsoft's Windows Media format as well as RealVideo. Boeing has a well-staffed streaming media production department, and occasionally uses outside vendors in order to insure

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[34] http://www.boeing.com/news/feature/757-300webcast/
[35] http://www.boeing.com/news/feature/717ff-webcast/index.html
[36] http://www.boeing.com/news/feature/sealaunch0399/
[37] http://www.boeing.com/news/feature/concept/index.html
[38] http://www.boeing.com/news/feature/shareholders2000/

sufficient production resources and bandwidth for major webcasts. All told, as many as 8000 video streams are delivered to Boeing employees over the company's intranet each week.[39] The company regularly produces five-minute company newscasts and key speeches by CEO Phil Condit are made available to all employees in streaming format.

Training

In addition to company news, over the past few years Boeing has developed a training and corporate communications program for direct delivery to employees' desktop computers via streaming video. The program, comprised of on-demand training videos from 10 minutes to one hour in length, has already yielded noticeable benefits. According to Peter Morton, vice president of the Boeing Center for Leadership and Learning, "This technology delivers a simultaneous increase in accessibility and decrease in program costs.[40]" However, others question if there is an unseen downside to placing significant emphasis on on-demand training via streaming video.

Harvey Hailer, manager of electronic media for Boeing's Learning, Education and Development Group, wonders if the convenience of streaming media may actually dilute the streaming message. "One of our concerns would be how much individuals value those programs. Right now, to attend a course in the classroom you have to sign-up, set aside time in your schedule, and plan your work around that classroom event. You really make a commitment to go to a learning experience. If steaming is available any time in your cubicle, then it doesn't seem to have the same value. How many other screens are you going to have open on your desktop when you're supposedly participating in a

[39] "Jet Streaming" p. 34

streaming learning experience? These are issues that we just don't have experience with."[41]

Still, with the cost benefits, it is hard to imagine an enterprise such as Boeing, turning its back on streaming technology. It seems reasonable that employees need to make adjustments to these new technologies (one's physical presence in a conference room, does not guarantee that proper attention is being paid) and if methods must be devised to improve retention or to ensure that employees are actually paying attention to important streaming training sessions, this must be addressed over time.

Multicasting

Even with its robust network infrastructure, Boeing does not have unlimited bandwidth and 200,000 employees simultaneously trying to connect to streaming video servers at 200 kbps is simply not practical at the moment, certainly not if the network is to be available for any other uses. At Boeing, engineering data needs take absolute priority over training and corporate communication videos. One solution does seem to be in the making: multicasting.

Most streaming media is unicast, requiring a unique server-to-client connection for every single user on the network. With this system, the client software is in constant communication with the server and can send information back to the server when necessary, for example, the client can ask that missed packets be resent.

With multicast streaming, one stream is sent to innumerable clients. This type of streaming is much more efficient since the data transmission is entirely one-way, from

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[40] "Streaming In", Fred Dawson, *Xchange Magazine*, August 15, 2000, http://www.xchangemag.com/articles/082feat6.html

the server to all clients on the network. Every client receives (or is intended to receive) every data packet sent, there is no real mechanism for monitoring traffic, resending missed packets or adjusting the speed of the stream. Multicasting is generally used for live events or re-broadcasting of live events and is especially desirable in situations where bandwidth it at a premium. However, multicasting requires a specially designed and configured network, where servers, clients, routers and switches are installed and tuned with the intention of supporting multicasting.[42]" The required complete control over the network architecture makes multicasting only practical in closed intranets at present.

Boeing is already working to multicast-enable its IP network[43]. As this new capability comes on line, valuable bandwidth will be made available for increased live webcasting of streaming media. Until then, Boeing, like other enterprises, will make use of interim solutions including protecting network bandwidth by routing unicast streams to buildings where they can be split-off to areas that are ready for multicasting as well as streaming important live events to places where groups of employees may watch together.

At a company like Boeing that is so heavily invested in satellite video delivery, streaming technology may not get the consideration it deserves. At this early stage in its development, streaming cannot compete across the board with well-established traditional delivery. One Boeing program that thus far has only made limited use of streaming technology through the IP network is the Boeing Education Network (BEN), a

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[41] "Jet Streaming" p. 31
[42] "RealServer Administration Guide: Multicasting Live Presentations" *Real Networks* http://service.real.com/help/library/guides/g270/htmfiles/multicst.htm
[43] "Jet Streaming" p. 31

training program that broadcasts 65 hours of original live educational programming via satellite to 85 classroom sites across the United States. BEN's programming utilizes live one-way video with two-way audio to provide a means for monitoring student response. Streaming might not provide much advantage in broadcasting to locations already served by this network, but seems like an easy way to bring additional classrooms into the program.

Recently, tests were conducted to see if live webcasts direct to user's desktops could be integrated into the existing BEN schedule. Success was limited, according to Harvey Hailer. "We didn't set up any interaction for the streaming sites because you've got people hearing it in real time, (other) people hearing it with a 2.5 second delay over satellite and people (on the web) hearing it 25 seconds later," he says. "Its pretty hard to take those three things and make it interactive for all three media. We anticipate that it's going to require a slightly different design to do stream courses as well. Streaming is definitely in the future, but it's a whole new arena."[44]

[44] "Jet Streaming" p. 31

Chapter 5 – Case Study: Sports

One area where corporate America is beginning to use streaming media to leverage its assets is in professional sports. MLB (Major League Baseball), the NBA (National Basketball League) and others are moving to expand their Internet offerings in an effort to develop new sources of revenue, deliver extra value to fans and rein in control of their properties.

Baseball

In June 2000, in an effort to exert maximum control over their product and try to collect additional revenue from Internet business opportunities, all 30 professional baseball clubs in the US banded together and created *MLB Advanced Media* (MLBAM), a new company specifically conceived to manage the websites of all teams and produce exclusive web-only multimedia programming.

The first product of a recently announced exclusive, three-year deal between MLBAM and RealNetworks, "Gameday Audio" allows baseball fans access to live audio webcasts (plus archives) of every single baseball game during the 2001 season for $9.95. Significantly, these audio streams are no longer available on the Internet for free as they were for the past few seasons. The deal is a coup for RealNetworks, as it stipulates that Major League Baseball deliver all Internet multimedia exclusively on their platform (the Real Player) in their proprietary streaming formats for three years;[45] fans wishing to tune

[45] MLB Advanced Media and RealNetworks announce exclusive, three-year agreement, Major League Baseball press release, March 27, 2001, http://www.mlb.com/NASApp/mlb/mlb/news/mlb_news_story.jsp?article_id=mlb_20010327_realnetworks_news&team_id=mlb

in to their favorite teams on the web won't be able to use Windows Media Player, QuickTime or streaming MP3 players.

Also included among the new offerings this year, are special customizable, on-demand, video highlights of each game played. This is touted as a new era for sports fans - subscribers are supposed to be able to edit together their own highlight "reels" from archives of each game played, to the point of watching individual pitches from any game they wish.

This deal is also significant in that it is completely based on a subscription model, showing that, perhaps, people are now willing to pay for Internet content. The success of football, baseball, hockey and other premium sports packages on cable television has proven that fans are willing to pay extra for an exclusive package of sports programming. Commenting on this particular element of the deal, Rob Glaser, Chairman and CEO of RealNetworks, Inc. said,

> "Like the cable television industry did so effectively in the 1970s, RealNetworks is now opening up the Internet as the next mass medium for distributing great sports content. We are methodically building a critical mass of top-tier, web-based sports content — and proving that subscription models on the Internet can and will be successful."[46]

Terms of the agreement, said to be the largest Internet deal to date involving professional sports, have not been made public, but *USA Today* reported that Major League Baseball is guaranteed $20 million by RealNetworks.[47]

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[46] MLB Advanced Media and RealNetworks Announce Exclusive, Three Year Agreement, RealNetworks press release, http://www.realnetworks.com/company/pressroom/pr/2001/mlb.html

[47] Fans Must Pony Up To Hear 'Batter Up!' On Web, Dow Jones Newswires, March 27, 2001

Basketball

The National Basketball Association has been a leader among sports leagues, experimenting with streaming media for the past four years. At first much of the content was made available for free, but recently, like Major League Baseball, the NBA is moving toward a subscription model. In 1999, the league partnered with RealNetworks to create "Audio League Pass," offering subscribers the ability to listen to audio broadcasts of every NBA game. This past season, audio of one game each night was presented by a major sponsor and made available for free. On April 13, 2001, the league made multimedia history as the regular season game between the Dallas Mavericks and the Sacramento Kings was the first-ever live video webcast of a major professional sports league game.[48]

In a recent article in *Streaming Media* magazine, NBA Commissioner David Stern summarized the league's perspective on this emerging delivery system:

> Streaming media offers sports consumers more control over their viewing experience, which can be synched up with stats, analysis and other features that sports content feeds. On-demand streaming media offerings such as NBA.com's *My Highlights* – through which users are able to determine exactly what players and plays they want to see and create personalized highlight reels – provide fans the functionality to create their own highlight shows at any hour of the day, rather than waiting for someone else's rendition at 6 or 11 o'clock.
>
> Even as reality begins to supersede hype, streaming media will not replace traditional television, cable and satellite outlets anytime soon. As a complementary experience to current methods of mass distribution, streaming media extends and enhances user experience, increases fan interactivity, and allows consumers to view the program when they want to. The future of streaming media promises yet another live distribution channel – one that reaffirms the significant appointment viewing aspect of sports.[49]

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[48] NBA Webcasts Game in Streaming Video, NBA.com
http://www.nba.com/theater/live_game.html?nav=ArticleList

[49] Nothing But Net, David Stern, Streaming Media Magazine, pp. 12-13.

Soccer

Recently United Soccer Leagues announced that 20 Saturday Night games during the 2001 season will be webcast live from the league's website. The league plans to offer the games for free to viewers by selling in-stream advertising.[50] While it remains to be seen if the Internet will become a significant source of income for professional sports leagues, one realm where streaming Internet video may make a profound difference is in the ability to connect sports fans with live high school and college sports.

College and High School Sports

In September 2000 the University of Nebraska-San Jose State game was the first Division I college football game ever streamed on the Web.[51] Other universities and colleges are experimenting with webcasting, imagining the potential to attract and perhaps solicit pledges from alumni around the world using football, basketball and other games.

With the exception of occasional city or state championship games, high school sports have always been a rarity on television. Internet webcasting may offer a reasonable alternative. While few high schools can afford the equipment or have the budget to produce high-quality streaming programming, other barriers common in the world of sports programming are not present at this level, for example webcasting high school sports rarely requires any incursion into the Byzantine world of sport television-rights negotiations though this could change if webcasting becomes very popular, especially if there is any money to be made in this area. For the few high schools that

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[50] "*Umbro Streams Saturday Night Soccer,"* StreamingMedia.com May 17, 2001. http://www.streamingmedia.com/printerfriendly.asp?id=7363

have dabbled in webcasting, the most common offering is a live web retransmission of a local radio broadcast. But to family and friends of the athletes, this may be enough for now.

The Illinois High School Association has been among the early adopters to webcast high school sporting events on the Internet. In May 2000 the annual spring state track and field meet was presented live on the web from Charleston. Every event in the meet, which featured more than 2,000 student athletes from more than 400 schools statewide competing, was included in the webcast. However, the production value of the webcast was not to be mistaken for a professional sports broadcast. The webcast was audio-only, and the play-by-play was supplied by tapping into the stadium announcer's microphone. Internet listeners were cautioned that, although historic, the webcast would not be even comparable to "…a radio broadcast. The stadium announcer does not speak continuously. Listen for a while and you will be able to hear: Competitor calls, Race introductions, Live descriptions of each race…"[52]

In the fall of 2000, the Illinois High School Association began to experiment with video by webcasting the Illinois state high school football championships. In neighboring Iowa the same month, The Iowa High School Athletic Association state basketball championships were broadcast live. Both associations produced their webcasts with Internet start-up iHigh.com, a high school news portal based in Lexington, Kentucky.[53]

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[51] *"Nothing but net,"* Wall St. Journal, March 13, 2001

[52] iHigh.com to Webcast Live from State Track Meets, Illinois High School Association press release, May 11, 2000, http://www.ihsa.org/announce/000511.htm

[53] iHigh.com Broadcasts the IHSAA State Basketball Championships in Streaming Audio, iHigh.com press release, March 16, 2001, http://iowa.ihigh.com/0,1682,1___35438,00.html

iHigh.com

iHigh.com has experimented with high school sports webcasting since 2000, producing a number of track and field, basketball and football webcasts. In most cases iHigh.com picks up local television broadcasts and invests approximately $3000 to encode and distribute each game on the Internet. In return for presenting games for free, the company negotiates the right to sell and insert commercials into the webcast.[54] In February 2001, iHigh.com teamed up with the Illinois High School Association to webcast final games of the boys and girls state basketball tournament, taking the signal produced by the IHSA TV network, which was broadcast over-the-air and on cable systems throughout Illinois, and presenting it on the Internet in RealVideo format.[55]

TrackMeets.com

TrackMeets.com, a start-up company at Syracuse (New York) University's Center for Advanced Technology in Computer Applications and Software Engineering is dedicated to webcasting non-mainstream sports that, as they put it on their website, "suffer the indifference of television." The company was started in 1998 by Syracuse University seniors Robert Alexander and Shoopong Yacharm, and Syracuse Computer Engineering Professor Kamal Jabbour, a track and field enthusiast who was frustrated by the lack of television coverage of major amateur track meets.[56] Jabbour realized that track and field and other running events attract millions of participants and spectators each year and could potentially support a viable niche programming business. "I decided

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[54] "Nothing but net," Wall St. Journal, March 13, 2001

[55] Illinois hoops - Live on the Net, iHigh.com, Feb 24, 2001.

[56] In The Beginning, TrackMeets.com website, http://trackmeets.com/aboutus.html#beginning

to do something about it other than complain," Jabbour told *Syracuse* magazine in the fall of 2000. "Computers are my domain, so I decided to start broadcasting track meets on the Internet."[57]

The company's first major project was the webcast the New York State Public High School Athletic Association Indoor Track and Field Championships, from the Carrier Dome in Syracuse on February 27, 1999. Since then trackmeets.com has produced numerous live webcasts of amateur sporting events including track meets, road races, field hockey, football, wrestling and lacrosse.

To highlight the difference between television and what is possible on the Internet, TrackMeets.com endeavors to show "every lap of every race" in a track meet. They did so when presenting the 2000 Canadian Olympic track and field trials, which drew more than 30,000 viewers August 11-13, 2000. An agreement with the 168th Street Armory track and field facility in New York City provided for TrackMeets.com to webcast live 85 meets between December 2000 and March 2001.

TrackMeets.com employs a combination of standard and proprietary technology refinements – primarily customized computers that are able to encode high bandwidth video in real time - which the company claims yield a higher quality webcast than others have yet been able to achieve in a production environment. Still, at this point in the evolution of streaming media, high quality means high bandwidth, and TrackMeets.com delivers their product at a much higher data rate – generally 512 kbps – than most commercial webstreaming services. The quality is quite good, but the audience is limited

[57]Syracuse University Magazine
http://www.sumag.syr.edu/fall00/features/trackmeets/trackpg2.html

to those with broadband Internet connections, such as cable modems, DSL, a T1 line or corporate (or campus) Ethernet.

TrackMeets.com is also slowly moving to offer webcasting services to business clients and has produced events for a number of clients in New York State. The company's website advertises very sketchy rates for webcasting: "Live production and broadcast of an event: about $1,000 per hour, depending on the size of the production and crew, plus travel expenses." Streaming content is served at the rate of $1 per hour per viewer, competitive pricing that perhaps reflect the lower costs the company enjoys as a result of its association with Syracuse University (where a steady supply of student interns keep labor costs low).

The jury is still out on whether webcasting of niche sporting event content will be profitable, but it appears that this is one area of great potential, where streaming media can bring to interested viewers live and archived programming they have no other possibility to view. Sporting events that have never been able to find an outlet on broadcast television, such as triathlons, have recently begun to appear on webcasts. This type of niche programming might someday deliver a devoted audience, the type truly valued by advertisers. In the meantime, such narrowcast streaming media programming fulfills the promise of the Internet to bring like-minded people together.

Conclusion

While it is still early to fully assess the impact of streaming technology on the media scene, its is not premature to conclude that this mode of communication holds great promise and is likely to have a major influence on the type and quantity of content available to viewers and listeners in homes and offices across America and eventually the entire world. Streaming media is already among the major forces transforming the Internet to a mass media delivery vehicle

As to how streaming will ultimately change the hegemony of a few giant media companies and their ability to control the flow of broadcast information, it is safe to say that streaming media is already proving to be an equalizer of sorts, allowing individuals, organizations and start-up companies to get their content to the masses. Of course established media companies have resources, marketing expertise and exclusive content that enable them to compete as smaller players cannot, but the evidence of just the past few years would tend to support the contention that “the genie is out of the bottle”.

Early experiments with streaming media are causing friction between some of the best known giants in the media world. Microsoft co-founder Paul Allen’s Charter Communications, the fourth largest operator of cable television systems in the United States, recently got into a well-publicized contract dispute with ESPN, 80% owned by the Walt Disney Company, over the potential impact of streaming media broadcasting.

According to press reports, Charter has become concerned enough about the appearance of Internet streaming programming to seek a reduction in the license fees it pays to cable program suppliers if those networks stream more than a set amount of their

programming on the Internet. Charter claims that such transmissions lower the value of their bread and butter: the television product they deliver over cable to millions of households, by allowing viewers to get for free content they pay for in the subscription fees. The cable company has proudly noted that over the past year and a half it has been able to put language limiting the right to offer streaming content into many programmer's renewal contracts.[58]

ESPN, which at present is only streaming live the audio portion of its "ESPNews" program, and Charter, which has more than 6 millions US households, locked horns when ESPN refused to agree to Charter's demand. Unable to work out a compromise, ESPN announced in early June that it would pull ESPNews from 1.3 million Charter homes that receive it. The issue is still unresolved, but it is clear that both media companies regard streaming media seriously enough to want to account for it in their future plans.[59]

At the moment, the number of viewers who regularly tune in to the Internet for ESPN or any other content provider's programming, is modest compared to typical broadcast audiences, but as more homes are connected to the Internet via cable modems or DSL, the demand for quality streaming programming will surely increase. Ironically, though cable operators are leading the push to provide broadband connectivity, they generally limit the bandwidth available to IP content, provisioning the lion's share of their system's capacity to their own lucrative subscription television offerings.

It remains to be seen if consumer demand will be a strong enough force to persuade the cable industry to re-consider this restrictive approach, but ultimately it will probably be consumers -- those individuals with content to stream and those who increasingly are

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[58] The Streaming Debate, *CableFAX Daily*, May 30, 2001, p.1

coming to expect that they can access, on-demand, programming on almost any subject through their computers -- who push streaming to the mainstream.

Assuming that streaming technology, bandwidth availability and computer power continue to improve at the rate they have in the recent past and that consumers will connect their televisions and stereos to devices that make it easier to "tune in" to IP streaming content, it is a safe bet that before long, IP streaming will become a practical alternative to traditional broadcast offerings and the line between broadcast and Internet television and radio will become indistinguishable.

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[59] Kicking and Streaming, by Laura Rich, *The Standard.com*, June 9, 2001, http://biz.yahoo.com/st/010609/26836.html