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Developer's Digital Media Reference

New Tools, New Methods

Curtis Poole

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Section I: Server-Based Architectures

CHAPTER 2

Streaming Video

This chapter provides all the information you need to understand the challenges, choose your tools, and then create and distribute video streams on the World Wide Web. For specific information on the various multimedia capabilities of the video platforms, as well as embedding and synchronizing video with graphics and other elements in Web pages, see Chapter 5, Synchronized Media.



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Streaming Content Explosion

Few Web technologies have caused more confusion, and stirred more excitement in recent years, than this thing called streaming video. This frenetic state of affairs is not likely to change soon. Thousands of attendees at streaming media conferences all over the world are living proof that streaming video has arrived at the mainstream for the Web-enabled community, if not the masses. According to the Deutsche Media Metrix Report from BT Alex Brown Research (March 2000), some 234 million hours of streaming content were projected to be delivered on the Web in 2000.

Like all the evolving Web technologies, streaming video involves many variations in terms of competing technologies and standards. But because video holds a certain cache (no pun intended), the stakes are especially high, leaving developers with a rich collection of options and a complex set of decisions to make when choosing technology paths.

Before those decisions can be made, developers must educate themselves on the fundamentals. What follows is a brief primer on the nature of streaming video as it might affect your basic choices of formats and distribution mechanisms. Toward the end of this chapter, you will find a checklist of information that will help you organize your basic technology decisions.

The Storage Challenge

How exactly does streaming video work, and why are the services so darn expensive?

One basic fact about video on the Web that we can all appreciate right away is that it takes a lot more storage space. The first generation of Website developers lived happily with 20 or 30 MB on a server somewhere. Next-wave developers of rich-media content are suddenly dealing in the gigabyte range in many cases. This represents a fundamental shift in storage requirements for Web content.

New high-capacity, high-performance server solutions such as Avid's Trilligent Cluster are geared specifically to this new dynamic at work on the Web. As a developer, expect to pay more for your Web presence as you start to store and deliver streaming content.

It's All in the Protocols

The second and more complex factor is the unique set of software requirements for streaming video. For the first time in the five- or six-year history of the World Wide Web, developers must reach outside of the familiar HTTP and TCP/IP protocols that made the first generation of content possible.

HTTP Streaming: The First Step

A few years ago, after RealAudio captured the imagination of the industry and stirred notions of real-time, full-motion video on the Web, Apple introduced the QuickTime progressive format with QuickTime 3.0 — a precursor to true streaming video that remains popular today for many applications. Also known as HTTP streaming, this type of progressive download allows the user to begin watching a video before the entire file has been transferred. HTTP streaming was meant to be an intermediate step on the road to true streaming, but for a number of reasons, which I will explain a little later, it remains an extremely useful format today in the delivery of short-form video.

As the name suggests, HTTP streaming allows you to deliver video from a traditional HTTP (Hypertext Transfer Protocol) server. When you link to a Web page that includes the embedded video, the contents of the video trickle progressively to the player. From that point on it's a race between the download speed and the rate of playback: after enough of the file is buffered, you can begin to play the file while in the background the remaining content continues to load from the server. If the playback runs beyond the download, playback stops until more of the content gets transferred. You then can resume playback, and so on.

As long as users have a lot of patience and developers use small video files, QuickTime progressive is a quick and simple solution that relies on existing HTTP server technologies. The development of broadband networks makes this solution even more acceptable, allowing for longer high-quality video clips to download quickly and play in something close to real time (a type of HTTP streaming content that has been dubbed DHS, for downloadable high-bandwidth stream). But what happens when you want to stream a one-hour program, without a hitch, in real time?

Real-Time Streaming Protocols

In contrast to HTTP, true streaming servers use real-time streaming protocols that include enhancements for real-time delivery, such as the ability to quickly calculate users' connection speeds and offer up alternate versions of the video with appropriate buffering rates. With true streaming protocols, digital data is transferred, displayed, and then discarded once you've seen it. As mentioned, with HTTP streaming the data is assembled in its entirety on the user's system and can be saved locally. With true streaming, although a 3- to 10-second cache of data is stored on the user's computer to compensate for network delays, at no point is the entire movie stored on the user's computer.

All these unique services and protocols come under the banner of either RTSP (real-time streaming protocol) championed by RealNetworks and others, or Microsoft's protocol for streaming from Windows servers using Win-

dows Media Technologies. RTSP is an open standard backed by the W3C (World Wide Web Consortium). Microsoft's protocol is proprietary.

As I will describe in Chapter 5 dealing with synchronized presentations, HTTP and streaming servers often work hand in hand to combine traditional Web content with streaming content. In most cases, the involvement of a streaming server on a Website is entirely hidden from the user.

Beyond TCP

Real-time streaming protocols vary from traditional Web protocols in some other ways. As you may know, TCP/IP are the dynamic duo, the Starsky and Hutch of first-generation World Wide Web standards, that make the effective transfer of data possible. At the server end, TCP (transmission control protocol) breaks all data into small packets and sends them on their way. At the user's computer — the receiving end — a checksum in the header information tells the receiving computer whether data was lost along the way. If it was, a new request for the missing data is sent to the server, which in turn sends the missing packets again. Once all packets are gathered at the receiving end, TCP reassembles the packets into their original form, as shown in Figure 2-1.

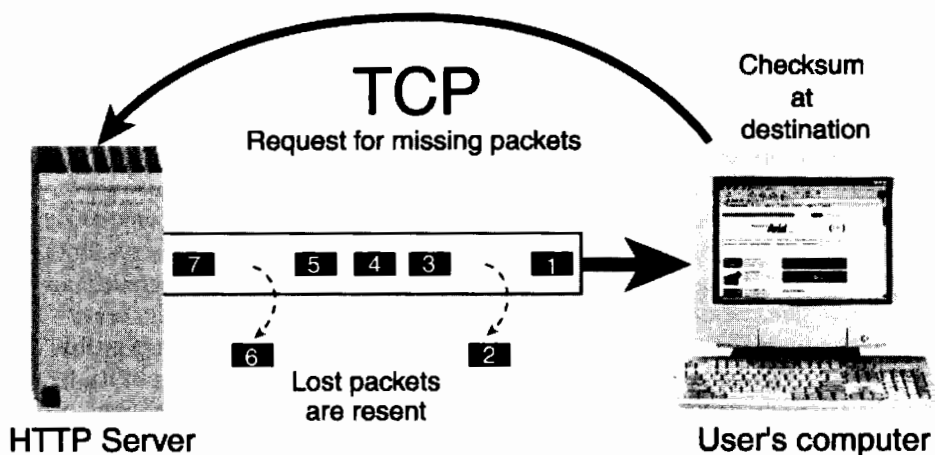


Figure 2-1 Standard Web Content via TCP/IP

As you can imagine, there is a delay here, however miniscule, that does not lend itself well to the steady march of frames that is the hallmark of video. That's where streaming video takes a new turn. Unlike Websites that use TCP, streaming servers use UDP (user datagram protocol). UDP does

not check to see if data has been sent, resulting in a more uninterrupted flow, as shown in Figure 2-2.

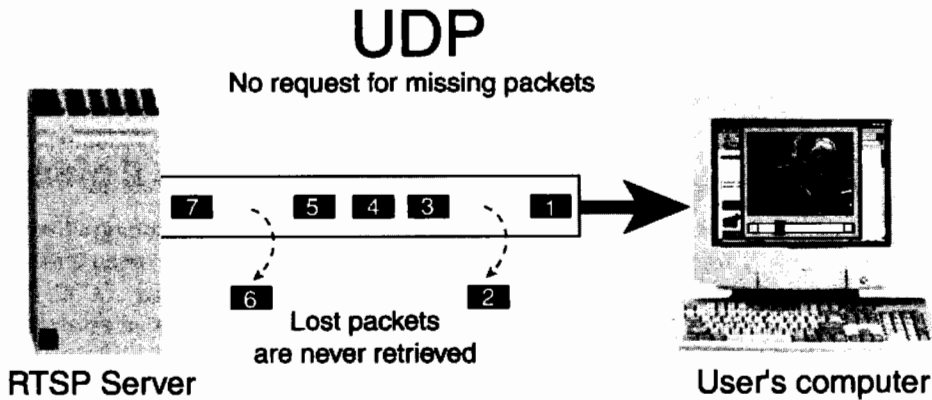


Figure 2-2 Streaming Content via UDP

This is why streaming video is sometimes referred to as a lossy Web technology, in which the user occasionally experiences dropped frames for the sake of uninterrupted flow of the program. When data-oriented applications on the World Wide Web require a high level of accuracy, the video experience is more forgiving, emphasizing overall flow above the loss of granular bits of information that are not always noticeable. With higher-bandwidth delivery, that loss of data occurs less frequently.

Beyond IP

The IP (Internet protocol) part has to do with routing the data from one location to another. The header portion of each packet of data sent on the Web includes information on where to send the data that can be interpreted along the way. You can think of that information as the mailing label, and the protocol at each location that interprets the information and routes it accordingly as the postal system of the information highway. At the moment, the current version of IP that is active across the World Wide Web uses a unicast model with point-to-point communication, which means basically that each computer communicates individually with the source or origin server, and the server in turn addresses data packets to each computer individually.

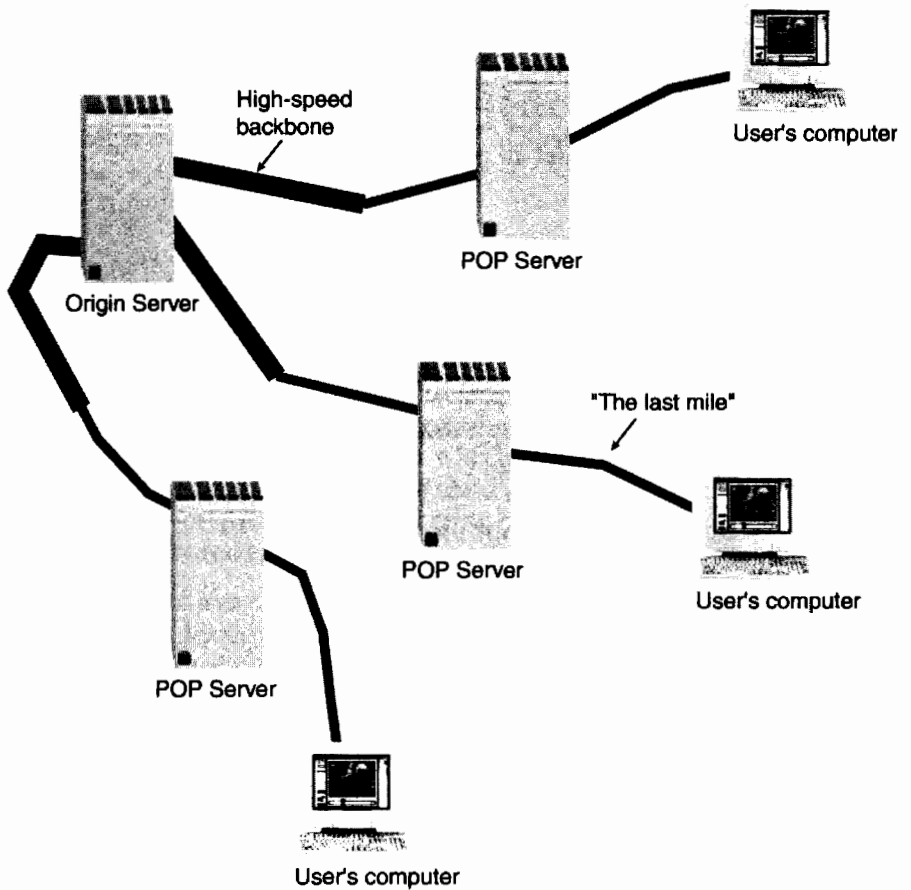


Figure 2-3 Unicast Distribution — Point to Point

Figure 2-3 shows the origin of the data, its transmission over high-speed backbones that make up the core of the Internet, and finally its transmission to the user from servers in a local point of presence (POP) network.

Problems with Unicasting

The unicast model works fine for the first plain-text-oriented generation of Web content. Again, we can easily imagine the problems this creates for video and other forms of streaming content. Coming from a “broadcast” tradition in which content is sent out from a single source, leaving it up to the receiving device to find that content on the airwaves or on the cable, video producers who are turning to the Web have been struggling to find new

models that are better suited to the rapid delivery of high-bandwidth streams to large audiences.

To give you a real-world example of the challenge, RealServer 7 is capable of providing 25 simultaneous unicast streams. RealServer Plus provides 60 streams. For most small independent developers with a dedicated T1 line connection to the Internet, 60 or 100 low-bandwidth streams remains the plateau for effective unicast delivery.

Taking It to the Edge

What happens when you need to reach thousands or even millions of simultaneous users? If you remember the Victoria Secret's Webcast fiasco in the year 2000, you know that it's been tried. As useful as that Webcast meltdown was as an education in the technology requirements of Webcasting to the masses, a better example for us to follow might be the NetAid fund-raising broadcast in October 1999. Using RealNetworks' distributed network and Cisco Systems' routers and solutions, the organizers of the NetAid Webcast successfully delivered a fundraising concert worldwide using more than 1,900 servers spread out over several dedicated networks with triple redundancy.

How did they do it? Imagine the unicast packet of data on its journey, traveling from a point of origin through the many wires and routers of the Internet until it reaches its destination. The longer the distance, the more convoluted the journey becomes, with more opportunities for the data to get lost or delayed.

To improve this situation, RealNetworks (www.reálnetworks.com, a partner in the NetAid Webcast) and a number of other large players, such as Akamai (www.akamai.com), InfoLibria (www.infolibria.com), Activate (www.activate.com), and Digital Island (www.digitalisland.net), do something known as network caching, or streaming from the edge. Using various means, these companies push content in advance out to regional servers so that the data is closer to end users; thus data arrives more quickly and more accurately when requested.

The first trick is to move the content around. When the streaming content is not live but is on demand, the content can be sent between other transmissions throughout the day until the full content is cached at the regional data center. Some companies, such as iBeam (www.ibeam.com) and Cidera (www.cidera.com), deliver the content via satellite to local and regional Internet service providers (ISPs). As in television, satellite delivery also allows for the possibility of live Webcasting.

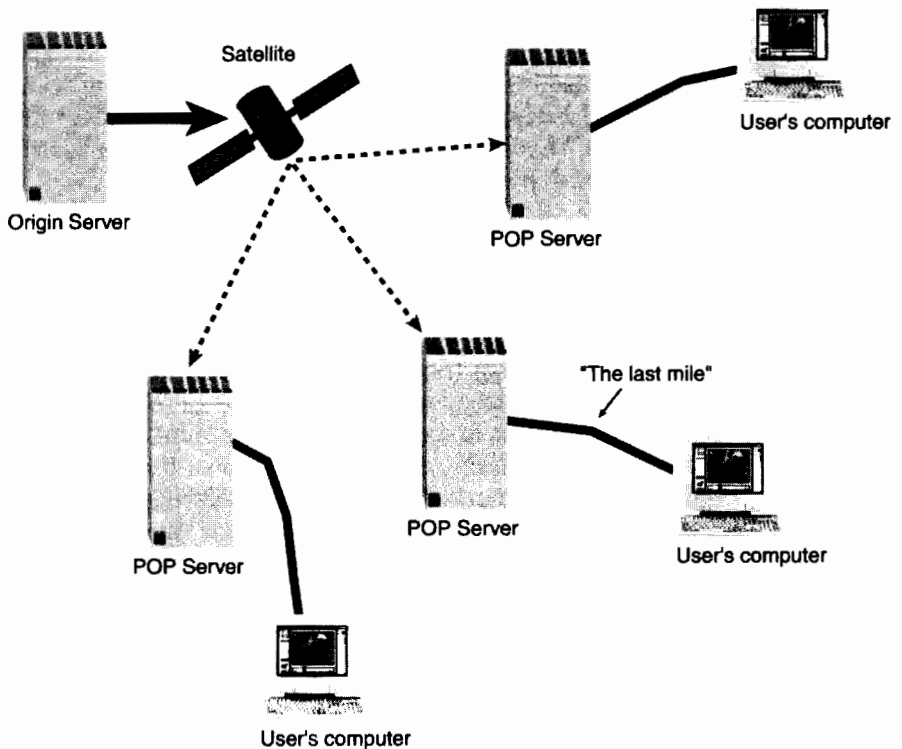


Figure 2-4 Unicast Distribution — Point to Multipoint

In Figure 2-4, satellite transmission is used to bypass a huge portion of the congested Internet to deliver the content directly to multiple servers within local POP networks.

Near-live Webcasting can also be achieved by leveraging some of the broadband infrastructure of Internet2 for at least part of the data journey. In the introduction to this section of the book, we described how Internet2 has developed as a staging ground for the next generation of Internet technologies, due soon at a theater near you.

The second trick is to determine which server will deliver the content to a particular user when that user contacts the Website. This feat is performed by the various proprietary code schemes, combined with mapping of the Internet, that have made these companies very successful and, in most cases, very expensive. With various dedicated servers, satellites, routers, and complex software involved in the task, many of these distributed “edge” delivery network services come with enterprise-level price tags.

Multicasting to the Rescue

If streaming from the edge is so expensive, what hope does a small producer have in reaching a large audience with quality video content? In a word, multicasting.

Another useful experiment conducted during the NetAid Webcast was a 1.5 Mbps stream via multicast on Internet2 to showcase a broadband version of the concert. Multicasting is a built-in feature of IPv6, the next generation of IP already in use on Internet2.

Multicasting, combined with the widespread use of broadband connection speeds among users, the keys for small producers trying to reach large audiences. In one stroke multicasting reduces network congestion, speeds data delivery, and removes the need for costly proprietary hardware solutions.

Multicasting uses a high-capacity Internet backbone, or multicast backbone (Mbone), for transmitting broadcasts using the IP multicast protocol. In multicasting, a single transmission includes the addresses of all those who want to see it. The data then makes copies of itself across the Internet when necessary and delivers copies to the local networks, and eventually to the individual users.

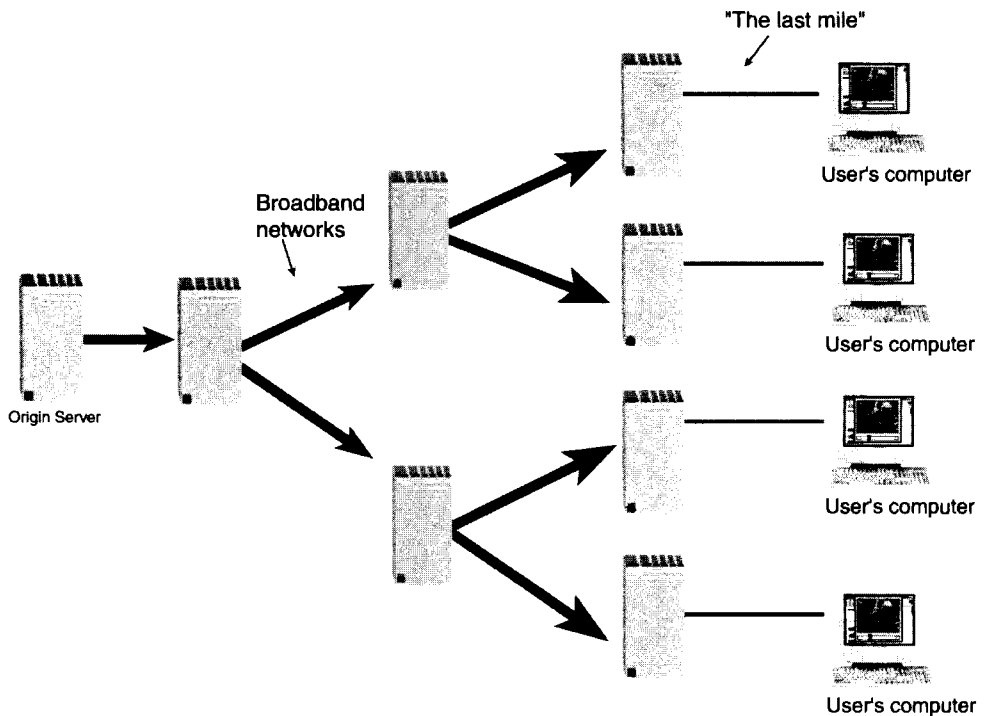
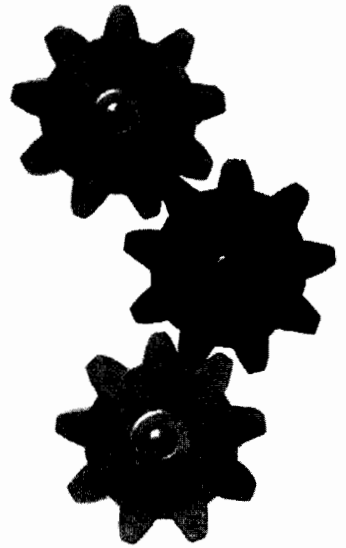


Figure 2-5 Multicast Distribution

As you can see Figure 2-5, the content that you, the developer, place on the origin server requires no further attention or expense. Multicasting allows a single transmission of the data to travel safely to multiple users. As with TCP/IP, the standard is open and free of charge. You can finally reach those thousands or millions of computer users without any trouble. Once those POP networks become GigaPOPs (the term used on Internet2 for local or regional networks with gigabyte-per-second transfer speeds), Webcasting of broadcast-quality video will become affordable and commonplace.

Part B: Tools

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Introduction

When it comes to streaming video, look no further than the big three: RealNetworks RealSystems, Microsoft Windows Media Technologies, and Apple QuickTime with the Sorenson codec. These three tool sets are very similar, yet different enough to require a careful review before making your choices.

MPEG-4 is emerging as an important, future-oriented technology that comprises video and several other motion-media technologies. The various MPEG technologies are described in detail in Chapter 15.

General Comparisons

The following tables offer high-level comparisons of various aspects of the big three streaming video tool providers. Table 2-1 shows media player penetration.

Table 2-1: Media Player Penetration*

Player	Number of Home Users
QuickTime	4.7 million (4%)
RealPlayer	32.7 million (28%)
Windows Media Player	22.1 million (22%)

*Source: Jupiter MediaMetrix, June 2001

Basic Features

Table 2-2 compares the availability of basic video technology features in the big three. For a comparison of multimedia features such as Flash support and text track capabilities, see Chapter 5, Synchronized Media.

Table 2-2: Streaming Media Formats — Basic Features

Feature	QuickTime	RealSystems	Windows Media
Automatic bandwidth selection	Requires QuickTime Reference movie creation; works for both HTTP and RTSP streaming	Requires RTSP streaming with SureStream	Requires Windows Media Services streaming with Intelligent Streaming

Table 2-2: Streaming Media Formats — Basic Features (Continued)

Feature	QuickTime	RealSystems	Windows Media
Automatic hinting	Requires addition of hinting track, some manual entry	Automatic	Automatic
De-interlacing	Yes	Yes, with RealVideo 8	Yes, with Windows Media 8
HTTP progressive streaming	Yes, QT 3 and greater	No	No
Inverse telecine	Yes	Yes, with RealVideo 8	Yes, with Windows Media 8
On-the-fly congestion detection and stream adjustment	Yes, with Sorenson 3	Yes	Yes
Platforms — development	Macintosh, Windows	Macintosh, Windows, Linux	Windows
Platforms — playback	Macintosh, Windows	Macintosh, Windows, Linux	Macintosh, Windows
Two-pass encoding	Yes, with Sorenson Developer Edition	Yes, with RealVideo 8	Yes, with Windows Media 8
Variable bit-rate encoding	Yes, with Sorenson Developer Edition	Yes, with RealVideo 8	Yes, with Windows Media 8

Windows Media Technologies

Go to www.microsoft.com/windows/windowsmedia

Quick Review

After much reengineering effort and various name changes — mostly marketing-driven — Windows Media Technologies finally came into its own with Version 7 of the Windows Media Player and Windows Media format 7 with companion authoring and encoding tools. Windows Media 8, which began shipping as a standard feature of Windows XP, consolidates the improvements.

Windows Media Player has been completely transformed, with the addition of skins that allow you to easily customize the look and functionality of the player. The player comprises seven features in a single application: CD player, audio and video player, media jukebox, media guide, Internet radio, portable device music file transfer, and an audio CD burner.

Versions 6.4 through 9 of the Windows Media Player also support Windows Media Video 8 and Audio 8. These most recent versions of the Windows Media formats lower even further the data rates required for delivering high-quality content. The new codecs can deliver near-CD-quality audio at 48 kbps (the same audio quality as typical MP3 encoding in a file nearly one-third the size) and true CD quality at 64 kbps. Windows Media Video 8 delivers near-VHS quality at 250 kbps (the low end of DSL/cable connection speeds) and near-DVD quality video at 500 kbps (full broadband connection speeds). Windows digital rights management features are also built right into Windows Media format 8. The upcoming Windows Media 9 release (codename Corona) promises true broadcast-quality video over broadband connections.

There are a few minor deployment issues to consider with Windows Media: Versions 7 or greater of the player are not supported on the Windows NT operating system, for example, but this can be easily overcome by utilizing Version 6.4 of the player on Windows NT, which supports all the recent formats with downloadable codec updates. The Macintosh version of the player also displays some shortcomings, but if your target audience is primarily the huge installed base of Windows users, Windows Media is an easy choice.

In terms of image quality, Microsoft claims parity, if not superiority, when compared with RealMedia, although RealNetworks presents counter-claims based on research. The new encoders now support de-interlacing to reduce flicker on computer monitors when displaying content that comes from an interlaced source, such as the National Television Standards Committee (NTSC) and phased alternating line (PAL)-based systems. It also supports inverse telecine for the first time, which results in improved playback quality of film-source content at lower bandwidths. Like RealMedia 8, the Windows Media format 8 also supports variable bit-rate (VBR) encoding.

In terms of sound quality, Microsoft strongly claims a superior audio codec, codeveloped with Intel. The Version 8 Windows Media Audio codec provides improved audio quality for narrowband Internet streaming of high-fidelity downloadable music. Improvements in quality over previous codecs have been made at all data rates, from 16 kbps to 192 kbps. Substantial improvements have also been made at 64 kbps and above. Perform your own tests to confirm.

In terms of deployment, Windows Media requires a Windows Media Server for streaming playback, which can be an advantage or a disadvantage depending on your circumstances. For example, if you have a Windows server readily available for deployment (in your workplace or with your ISP), then Windows Media might be a good choice for you. With a minimum of fuss, you can reconfigure the server with Windows Media Services, and you're on your way.

On the other hand, you cannot deploy Windows Media through current versions of RealServer or QuickTime Streaming Server software because

Windows employs its own proprietary streaming technologies, whereas RealServer and QuickTime Streaming Server both conform to the open RTSP standard. Note, however, that the upcoming version of RealNetworks server technology, known as Helix, promises support for all streaming formats, including Real, QuickTime, Windows Media, and MPEG-4, for the first time in a single platform.

Perhaps the biggest draw for Windows Media Technologies is low cost; most of the tools, in fact, are free. However, although the tools are free, RealNetworks rightly points out that there are other expenses involved, depending on the full range of hardware and software requirements, your target audience, and chosen delivery formats — not to mention the fact that you are bound to the Windows platform. You can download the most recent version of the the Windows Media Player, Encoder, and various authoring tools directly from the Microsoft Website.

There isn't a great wealth of third-party tools and information to ease the development process, however. A search at Amazon.com turns up three titles of recent vintage, only two of which provide any useful information for developers (the third is consumer-oriented). In addition, both developer guides are Microsoft publications, so don't expect much mention of or comparison with rival technologies.

Table 2-3 and Table 2-4 cover video codecs and audio codecs, respectively. They also contain descriptions of the codecs.

Table 2-3: Video Codecs for Windows Media Player

Codec	Description
Windows Media Video V8	V8 improves compression efficiency an additional 30 percent over the technically acclaimed Windows Media format 7, according to Microsoft. It provides advanced features such as variable bitrate encoding, de-interlacing, and inverse telecine. Playback using this codec requires modern computers with fast CPU speeds.
Windows Media Video V7	Use the V7 codec when your computer or target computers are not powerful enough to accommodate the performance demands of the Windows Media Video 8 codec. Also use the Windows Media Video 7 codec if your users play content in Windows Media Player 7 and you do not want to force a download of the Windows Media Video 8 codec.
ISO MPEG-4 Video	For most encoding scenarios, you should use Windows Media Video 7 or 8 codecs. The ISO MPEG-4 video codec supports the ISO/IEC standard and enables you to encode and play content that is compatible with ISO MPEG-4.
Microsoft H.263	H.263 is good for providing low to middle bit-rate video. This codec is optimized for videoconferencing, so it is a good choice for presentations and other low-motion video content.

Table 2-4: Audio Codecs Installed with Windows Media Player

Codec	Description
Windows Media Audio V8	The Windows Media Audio 8 codec is appropriate for most uses and encodes audio streams at bit rates of 16 kilobits per second (kbps) to 192 kbps. Use the ACELP codec for voice encoding at low bit rates only.
Windows Media Audio V7	The Windows Media Audio 7 codec can be used for most types of audio streams at bit rates of 16 kbps to 192 kbps. Use the Windows Media Video 7 codec if your users play content in Windows Media Player 7 and you do not want to force a download of the Windows Media Audio 8 codec. Use the ACELP codec for voice encoding at low bit rates only.
Sipro Labs ACELP.net codec	ACELP is a low-bit-rate codec that provides excellent voice compression. ACELP comes with several audio formats, depending on the network bandwidth you choose.

Tools and Tasks

This section provides reference information about Microsoft's free tools for creating Windows Media files, converting other file formats to Windows Media formats, and adding URL flips and other functionality into Windows Media streams.

Windows Media Encoder

Go to www.microsoft.com/windows/windowsmedia/download

The Windows Media Encoder enables both live and on-demand content production with the following features:

- Includes template-based encoding options
- Controls for scaled encoding
- Allows you to insert script commands and URL flips on the fly
- Includes various programmability and administration features
- Supports a variety of capture cards
- Includes special encoding capabilities such as support for de-interlacing, inverse telecine, and screen capture
- Includes an easy process for creating screen capture and training demos using the Windows Media screen capture codec
- Supports multigigabyte files and uncompressed capture directly to Windows Media format and creates archive files that are more than 30 GB in size. This capture feature, combined with support for capturing uncom-

pressed audio and video, provides previously unavailable capture and archive capabilities

- Enables encoder-based time compression, allowing users to adjust pause removal and playback expansion of audio and video files, which further reduces playback time

Windows Media Resource Kit

Go to www.microsoft.com/windows/windowsmedia/download

The Windows Media Resource Kit offers a full range of tools for creating and editing live and on-demand Windows Media-based content. The kit also includes the popular utilities first introduced in Windows Media 4.1, Digital Broadcast Manager and Windows Media Tools 4.1. These tools are available for free.

Table 2-5 lists recommended tools for a variety of common authoring and editing tasks.

Table 2-5: Windows Media Tools

Task	Recommended Tool	Description
Delete portions of video	ASFChop	This command-line utility crops time periods of a Windows Media file and adds indexes, script commands, markers, and general properties to the file.
Add script commands and events to ASF files	ASF Indexer	This adds properties, markers, script commands, and indexes to an existing Windows Media file.
Distribute encoding among computers	Encoder Controller	It provides frame-accurate playback control for multiple-computer encoding sessions.
Combine multiple video clips	Stitcher	This combines multiple Windows Media files into a single Windows Media file by concatenating the source files in the order defined by the user.
Set up batch encoding	Windows Media Encoder Remote Setup Utility	It is used to automatically configure the DCOM settings for the computer on which it is running, enabling the Windows Media Encoder 7 Automation interfaces to perform properly.
Batch encoding	Windows Media Encoder Batching Utility	It is used to encode multiple files that are not in Windows Media format and save them as Windows Media files with a .wmv extension.

Table 2-5: Windows Media Tools (Continued)

Task	Recommended Tool	Description
Install Windows Media 7 codecs	WMPcdcs	This command-line utility installs the Windows Media Video Version 7 and Windows Media Audio Version 7 codecs on a computer that uses Windows Media Player Version 6.4.
Add script commands and events to WMV or WMA files	Windows Media Advanced Script Indexer	It enables you to edit scripts and markers within any Windows Media file and place those scripts in the header portion of the file.
Play audio files	AudioPlayer	It is used to play Windows Media files through a simple user interface (UI).
Do simple file conversion to WMV	AVIToWMV	This command-line utility is used to convert uncompressed files from either the AVI format or the WAV format to Windows Media format.
Play audio files	WMAPlay	This command-line utility is used to play Windows Media files with a .wma extension.
Modify metadata	WMAAttr	This allows you to display and modify the metadata properties for a Windows Media file.
Capture video	WMCap	This is a digital video capture tool.
Display clip properties	WMPProp	This command-line utility is used to show some properties of a Windows Media file.
Convert multicast to unicast	WMSProxy	This is a tool to convert a multicast stream to an HTTP unicast stream.
Combine two WMV files	WMVAppend	This command-line utility is used to create an output file from the content of two Windows Media input files.
Simulate streaming of a file	WMVNetWrite	This command-line utility is used to show how a Windows Media file is streamed across the Internet.
Clean up metafiles	Windows Media MetaFile Cleaner	This command-line utility removes unsupported tags and attributes from existing metafiles, which Windows Media Player 7 identifies as not valid and does not support. It then creates valid metafiles.
Create metafiles	Windows Media MetaFile Creator	This tool, through its graphical user interface, is used to automatically create Windows Media files with .asx extensions based on specified information.

Table 2-5: Windows Media Tools (Continued)

Task	Recommended Tool	Description
Verify ASF headers	Windows Media Mobile Utility	This command-line utility is used to verify ASF header section compatibility with mobile terminals from NTT DoCoMo.
Simulate server load	Windows Media Load Simulator	It is used to create a real-world load on a server by simulating Windows Media Player connections.
Monitor streaming connections	Windows Media Monitor	This is a Web page that monitors the connections of up to eight streams simultaneously by using instances of the embedded Windows Media Players.
Get a dynamic IP address over a network	GetDynamicIP	This tool establishes a static port connection between a Windows Media Server hosting a broadcast unicast publishing point and a computer running a Windows Media Encoder that has a dynamically assigned TCP/IP address.
Send an IP address over a network	SendIP	This tool establishes a static port connection between a computer with a dynamically TCP/IP address running Windows Media Encoder and a Windows Media Server hosting a broadcast unicast publishing point.
Encode media	Windows Media Encoder	This tool encodes media content into a Windows Media format stream or file. Content can include stored multimedia files or live input from a microphone or video camera. Windows Media Encoder converts and compresses audio content, video content, and script commands into Windows Media format using state-of-the-art compression technologies.
Broadcast a presentation	Presentation Broadcasting	This feature of Microsoft PowerPoint 2000 integrates with Windows Media Technologies to make it easier to create and publish PowerPoint presentations in Windows Media format. With Presentation Broadcasting, you can broadcast streaming PowerPoint presentations to network users in real time. In addition to broadcasting PowerPoint slides, presenters can broadcast video and audio simultaneously to deliver a live multimedia show online and then store their presentations for on-demand playback.
Generate Windows Media files from within Premiere	Windows Media Plug-in for Adobe Premiere	This tool saves, compresses, and converts your video files into Windows Media format from within Adobe Premiere.
Convert PowerPoint 97 files to Windows Media	Windows Media Presenter for PowerPoint 97	This add-in tool, along with Windows Media Encoder, helps you convert a PowerPoint presentation to a Windows Media format stream.

Table 2-5: Windows Media Tools (Continued)

Task	Recommended Tool	Description
Convert PowerPoint 97 files to ASF	Windows Media Publish to ASF for PowerPoint 97	This add-in tool combines PowerPoint presentations with narration.
Convert video files to ASF	VidToASF	This command-line utility converts .vid or .mov files into Windows Media files. You can use a command-line option to specify script files that add markers, invoke URLs, and execute script commands.
Convert WAV files to ASF	WavToASF	This command-line utility converts .wav or .mp3 files into Windows Media files. You can use a command-line option to specify script files that add markers, invoke URLs, and execute script commands.
Check and repair ASF files	ASFCheck	This command-line utility verifies Windows Media file formats. ASFCheck can identify problems within a Windows Media file and repair some of the identified problems.
Manage Windows Media content	Windows Media Digital Broadcast Manager	This tool enables application service providers (ASPs) and Internet content providers (ICPs) to develop ways to manage, deliver, and sell pay-per-stream and pay-per-download multimedia content over the Internet by using Windows Media Technologies. This component runs on the Windows NT Server and Windows 2000 Server operating systems in conjunction with Windows Media Services, Site Server Commerce Edition, and SQL Server. All of these components must be installed prior to installing Digital Broadcast Manager.

PowerPoint Conversion Tools

The tools described in Table 2-6 are included with the PowerPoint software, available stand-alone or as part of the Microsoft Office suite of products from most software vendors.

Microsoft Producer also allows you to work with PowerPoint in the context of synchronized presentation authoring. For more information, see Chapter 5.

Table 2-6: PowerPoint Conversion Tools

Task	Tool	Features
Create live audio and video synchronized with Microsoft PowerPoint 2000 slides	Presentation Broadcast (part of PowerPoint 2000)	It provides archiving for later on-demand access. Slide changes are synchronized with presenter's audio and video. Only the presenter needs PowerPoint 2000. Clients need Windows Media Player and a Web browser.
Create live audio and video synchronized with PowerPoint 97 slides	Windows Media Presenter for Microsoft PowerPoint 97	It provides archiving for later on-demand access. Slide changes are synchronized with presenter's audio and video. Only the presenter needs PowerPoint 97. Clients need Windows Media Player and a Web browser.

Microsoft Producer

Go to www.microsoft.com/windows/windowsmedia/technologies.asp

Microsoft Producer is a user-friendly environment for building synchronized presentations from a range of Microsoft products and Web technologies such as PowerPoint, Windows Media, HTML, and image files. For more information, see Chapter 5.

Windows Media Services

Windows Media Services is built directly into the Windows 2000 Server, offering easy integration with corporate infrastructures. No additional per-stream or per-seat licensing is required for Windows Media, thus minimizing deployment costs.

In terms of streaming capabilities, ZD Labs has independently documented more than 9,000 concurrent narrowband streams and more than 2,400 broadband streams on a single server running on Windows 2000 Server and Windows Media Services.

The tight integration between Windows Media Services and Windows 2000 creates a highly reliable streaming platform. A streaming server needs

to deliver millions of time-sensitive data packets to multiple clients — if a given packet isn't received in time to be played, users experience poor quality. ZD Labs also measured the reliability of Windows Media Services — and reported that Windows Media Services delivered 26 billion packets of data with 99.9999999 percent accuracy over more than 12 days of continuous streaming of more than 2,400 broadband streams.

Windows Media Rights Manager

Go to www.microsoft.com/windows/windowsmedia/download

Microsoft Windows Media Rights Manager is an end-to-end digital rights management (DRM) system that offers content providers and retailers a flexible platform for the secure distribution of digital media files.

Windows Media Rights Manager was first released in August 1999. The latest release includes both server and client software development kits (SDKs) that enable applications to protect and play back digital media files. The SDK is sent to you after Microsoft accepts a signed SDK license agreement from you.

Additional Microsoft Resources

Go to www.microsoft.com/windows/windowsmedia/technologies.asp

You can find the following additional resources at the Microsoft Windows Media Web location noted above:

- Training materials and tutorials
- Downloads
- Developer center
- Additional developer community links

Third-Party Tools

The companies listed in Table 2-7 offer compatible tools for Windows Media authoring, audio and video processing and production, capturing, and compression.

Table 2-7: Windows Media Third-Party Tools

Company	Go To	Product
Adobe Systems, Inc.	www.adobe.com	Adobe Premiere
Avid Technology, Inc.	www.avid.com	Avid Cinema, Avid Xpress DV, ePublisher

Table 2-7: Windows Media Third-Party Tools (Continued)

Company	Go To	Product
Autodesk Inc.	www.discreet.com	Cleaner
Liquid Audio, Inc.	www.liquidaudio.com	Liquifier Pro, Liquid MusicServer, Liquid MusicPlayer
Sonic Foundry, Inc.	www.sonicfoundry.com	Sound Forge 4.5, Stream Anywhere, Vegas Pro
TegoSoft Inc.	www.tegosoft.com	TegoSoft's NetShow-based product
Telos Systems	www.telos-systems.com	Audioactive
Ulead Systems, Inc.	www.ulead.com	MediaStudio Pro 5.0

Before selecting a third-party vendor to provide services or products, you should conduct a thorough independent review of the third-party vendor's ability, skills, experience, and/or products to determine whether the third party can fulfill your particular needs.

RealNetworks RealSystems

Go to www.realnetworks.com/products

Quick Review

In the streaming media arena, RealNetworks has been a company of firsts. The RealAudio format and player, for example, was the first technology to create excitement around the potential of streaming media. Since the success of RealAudio, RealNetworks has continued its role as an innovator, usually coming first to market with each new step up in the quality of streaming media, while also championing the rapid development of various open standards such as RTSP and SMIL.

In terms of image quality, RealNetworks can also stake a claim to delivery of the first VHS-quality broadband streams beginning with RealSystem G7 — although Windows Media and QuickTime, with the Sorenson 3 codec, were not far behind. RealVideo 8 (with the RealSystem iQ platform) and the new Helix family of technologies also stake their claims at the top of the new wave of broadband video content.

RealSystem 8 streaming technologies allow you to target up to eight different bandwidths, while the RealServer software intelligently and dynamically negotiates between them. The full power and control of VBR and two-pass encoding allow you to achieve half-screen VHS quality at only 300 kbps.

The successor to the RealSystem G7 platform is RealSystem iQ, which replaces Version 7 player and server software with Version 8. Version 8 includes modern features such as two-pass VBR encoding and de-interlacing for the first time.

With the RealOne platform, launched in the fall of 2001, RealOne combined a consumer subscription service for viewing and listening to streaming content with a newly integrated media interface that includes the functions of RealPlayer and RealJukebox with a media browser, as well as a content discovery window where related information and links can be displayed. The new Helix platform builds on this model while delivering all the major streaming formats from a single server.

Because RealNetworks is not an OS company, RealSystem software (as you might expect) supports more operating systems than its competitors (including Windows, Linux, Solaris, and Macintosh).

Video and Audio Codecs

RealNetworks keeps things simple when it comes to codecs supported in the RealPlayer: depending on your chosen platform, you have but one set of proprietary codecs, period. So, the only real question is, which audience do you need to reach? Can you target a cutting-edge audience and challenge them to upgrade their players to Version 8 or Helix? Or, do you need to backtrack and capture a larger audience with the RealVideo G7 platform? You might even have that rare case when you must go all the way back to the G2 platform (for example, on a corporate intranet where the IS department has not yet upgraded).

Tools and Tasks

This section provides reference information about RealNetwork's tools for creating, manipulating, and delivering RealMedia files. These tools are also bundled in various special packages that you can learn more about at the RealNetworks.com home page.

RealSystem Producer Plus

Go to www.realnetworks.com/products/producer

Producer Plus (for RealMedia 8) or the newer Producer and Producer Basic for Helix are the standard tools for creating RealSystem audio and video. Producer Plus and the new Producer include the following basic features:

- Encoding for multiple bandwidths: You can simultaneously create one file for up to eight different connection speeds.

- **Two-pass, VBR video encoding:** Producer can scrutinize the entire video clip before it starts to encode and then assign more bandwidth to complex parts of the presentation — improving quality across all bandwidths.
- **RealMedia Editor:** It is a timeline-based editing tool that allows you to change start and end times, paste files together, view stream properties, and preview any RealAudio or RealVideo files.
- **Bandwidth simulator:** This is a feature that allows you to preview and simulate your presentation in a variety of network scenarios.
- **Video scaling:** It allows you to import video at any size and use RealProducer Plus to scale the image size down for the Web.
- **Multiple platforms:** They are available for your choice of a number of Windows, Linux, Sun Solaris, and Apple Macintosh server platforms. Helix adds Free BSD, IBM, Hewlett-Packard, and Compaq platforms.
- **Backwards compatibility:** RealVideo 8 will stream from any RealServer from Version G2 or later.
- **Automation ActiveX/AppleScript/batch encoding:** It allows you to integrate RealProducer Plus functionality into your production system using integrated ActiveX or AppleScript components or to utilize the command-line encoder for batch scripting.

RealSlideshow

Go to www.realnetworks.com/products

RealSlideshow allows you to add still images to a stream and synchronize them to RealAudio. RealSlideshow provides the following:

- **Layout control, cropping and resizing of images, linking and graphic capabilities:** Use these to create dynamic RealAudio slideshows.
- **Text captions:** Use synchronized text captions to accompany the images and audio.
- **Hyperlinks:** Add hyperlinks to each image.
- **Persistent images:** Use a persistent image either to produce a logo for corporate identity or branding or to provide a theme to a particular presentation.
- **Images and sounds:** Free images and sounds are included.

RealSlideshow can import MP3s or work directly with audio discs in your computer's CD drive. It can work with most common image formats including PNG, JPEG, GIF, and BMP.

RealPresenter

Go to www.realnetworks.com/products

RealPresenter allows you to incorporate Microsoft PowerPoint presentations into your streaming content. RealPresenter includes the following:

- **RealVideo 8 support:** This allows use of Version 8 RealMedia formats.
- **Table of contents:** This allows users to jump ahead while viewing their presentation.
- **Microsoft PowerPoint 97 and 2000 integration:** It allows you to record, broadcast, and publish Internet presentations directly from PowerPoint.
- **Free integrated RealSystem Server:** You can broadcast live or archived presentations to 25 concurrent users right from your desktop (requires RealPresenter Plus).
- **Wizards:** These provide simple and intuitive ways to add audio and video to your presentations, edit and rerecord, and then publish them for your audience to see and hear.
- **Integrated email capability:** It allows you to notify your audience about the presentation and then use email to interact with them in real time during live broadcasts.

RealServer

Go to www.realnetworks.com/products/

RealNetworks provides a variety of server software products to choose from, depending on your needs and budget. Visit the Web location shown above for latest package combinations and pricing.

RealText, RealPix, and RealFlash

These solutions allow you to add various multimedia capabilities to your Real Media streams, and are discussed in detail in Chapter 5, Synchronized Media.

Additional RealNetworks Resources

Go to www.realnetworks.com/devzone

You can find the following additional resources at the RealNetworks DevZone Web location:

- **GRiNS Editor Pro** (allows you to create and edit RealSystem SMIL presentations)

- RealSystem plug-ins for Dreamweaver and Adobe GoLive
- Additional third-party plug-ins and tools
- Knowledge base, documentation, tutorials, and other useful information

Third-Party Tools

The companies listed in Table 2-8 offer compatible tools for RealMedia authoring, audio and video processing and production, capturing, and compression.

Table 2-8: RealMedia Third-Party Tools

Company	Go To	Product
Adobe Systems, Inc.	www.adobe.com	Adobe Premiere
Avid Technology, Inc.	www.avid.com	Avid Cinema, Avid Xpress DV, Avid ePublisher
Autodesk Inc.	www.discreet.com	Cleaner 5
Liquid Audio, Inc.	www.liquidaudio.com	Liquifier Pro, Liquid MusicServer, Liquid MusicPlayer
Sonic Foundry, Inc.	www.sonicfoundry.com	Sound Forge 4.5, Stream Anywhere, Vegas Pro
TegoSoft Inc.	www.tegosoft.com	TegoSoft's NetShow-based product
Telos Systems	www.telos-systems.com	Audioactive
Ulead Systems, Inc.	www.ulead.com	MediaStudio Pro 5.0

Before selecting a third-party vendor to provide services or products, you should conduct a thorough independent review of the third-party vendor's ability, skills, experience, and/or products to determine whether the third party can fulfill your particular needs.

QuickTime

Go to www.apple.com/quicktime

Quick Review

QuickTime, the granddaddy of multimedia authoring tools, is now more than 12 years old, and after years as the default format for CD-ROM development, QuickTime shows great depth in terms of robustness and richness of features. QuickTime was also the first to go cross-platform, and it took

the streaming world by storm when it introduced fast-start HTTP streaming with QuickTime 3 in the early days of streaming video development. Various iterations of QuickTime 4 introduced a slew of solid streaming media features, and the renegade QuickTime Streaming Server went open source in 2000.

But, as the saying goes, what have you done for me lately? A lot. The open-source QuickTime Streaming Server, along with QuickTime 5 and the Sorenson 3 codec plus newcomer On2 Technologies Inc., reestablished QuickTime's parity among the big three, with high-quality, quick, low-bandwidth VBR encoding and playback, as well as a number of enhancements to streaming capabilities including the addition of DSL and cable modem to the list of connection speeds, as well as enhanced skip protection during streaming. QuickTime 6 introduces support for both MPEG-4 and MPEG-2.

QuickTime also retains its lead as a development platform, with a robust hardware-independent container structure and full-featured support for working with the widest range of media types of the big three. See Table 2-9.

Table 2-9: QuickTime Video Codecs

Codec	Description
Animation	For high-quality lossless compression (in which no picture information is lost). Encodes each pixel using a run-length coding scheme. Results in a file that is 70 to 95 percent the size of the uncompressed file. At the maximum quality, this is a lossless compression (in which no picture information is lost).
Apple BMP	A bitmap image format.
Apple Video	Generic desktop video format.
Cinepak	For export at low resolution for use in contexts where high quality is not an issue, such as presentations or educational uses, or for small-screen size playback from CD-ROM or hard drive. Uses compression algorithm optimized for CD-ROM playback.
Component Video	For high-quality lossless compression (in which no picture information is lost). Uses the same algorithm as the Animation method but saves the file in YUV RLE format, which separates the luminance from the chrominance. All QuickTime applications can read this format, but only some can write to this format.
DV NTSC and PAL	Apple's high-quality implementation of the industry-standard DV format for video.
Graphics	For export at low resolution for use in contexts where high quality is not an issue, such as presentations or educational uses, or for small-screen-size playback from CD-ROM or hard drive. Uses a limited color palette version (16 colors) of Animation compression.

Table 2-9: QuickTime Video Codecs (Continued)

Codec	Description
H.261	Video format originally created for videoconferencing purposes, optimized for low data rates with little motion in the picture.
H.263	Video format originally created for videoconferencing purposes, optimized for low data rates with little motion in the picture.
Intel Indeo Video	A video format created by Intel for use primarily on CD-ROM.
Microsoft RLE	A video format created by Microsoft for playback in Windows Media Player.
Microsoft Video 1	Creates files that will play in older versions of the Windows Media Player.
Motion JPEG A	For medium-quality lossy compression (in which some picture information is lost), requiring much storage space and additional hardware support for real-time playback. Motion JPEG (M-JPEG) is a variant of the ISO JPEG specification for use in digital video. Considered the standard for Motion JPEG, format A is supported by chips from Zoran and C-Cubed.
Motion JPEG B	For medium-quality lossy compression (in which some picture information is lost), requiring much storage space and additional hardware support for real-time playback. Motion JPEG (M-JPEG) is a variant of the ISO JPEG specification for use in digital video. Format B cannot use the markers that ISO JPEG and format A do; supported by chips from LSI.
None	For high-quality, lossless compression (in which no picture information is lost). Does not compress the file; results in very large files.
On2 codecs	QuickTime 5 or greater allows you to download and install additional codecs from third parties. The most notable in this category are the codecs from On2 Technologies. These include codecs such as VP3 and VP4, with compression quality that equals or in some cases surpasses Sorenson Video. For more information, visit www.on2.com .
Photo-JPEG	For medium-quality lossy compression (in which some picture information is lost), requiring moderate storage space and data throughput on playback. Uses the Joint Photographic Experts Group (JPEG) algorithm for image compression; results in files that are 20 percent to 30 percent the size of the uncompressed files. Some data is lost during compression, and the export process takes longer to complete (typically six times longer than the Animation compression, for example).

Table 2-9: QuickTime Video Codecs (Continued)

Codec	Description
Planar RGB	For high-quality lossless compression (in which no picture information is lost). Results in large files. Encodes each image plane separately, using a run-length encoding scheme. Used primarily to support Photoshop files, which are usually stored using a planar run-length algorithm.
Sorenson Video	Medium-quality lossy video format optimized for use in low-bandwidth situations on the Web or for broadband use on CD-ROM. The most popular QuickTime multimedia format.

The audio codecs listed in Table 2-10 are installed with QuickTime. MP3 is always a good choice, but it requires greater CPU speed than some others and can prove to be too much of a challenge on older systems. The old standard IMA 4:1 compression remains solidly supported on the widest range of sound cards.

Table 2-10: QuickTime Audio Codecs

Codec	Description
IMA 4:1	An older but highly reliable codec supported on most sound cards.
MP3	MPEG layer 3 audio, the de facto Web audio standard. Always a good choice, but requires greater CPU speeds than some other codecs.
QDesign Music 1 and 2	From QDesign, optimized for use with music tracks.
Qualcomm PureVoice	From QDesign, optimized for use with voice tracks.

Import File Formats

The following formats can be imported directly into the QuickTime Player (requires QuickTime Pro):

- 3DMF
- AIFF
- AU
- Audio CD Data (Macintosh)
- AVI
- BMP
- DV
- FlashPix
- GIF
- JPEG/JFIF
- Karaoke
- MacPaint
- Macromedia Flash
- MIDI
- MPEG-1 (Macintosh)
- MPEG-1, Layer 3 (MP3, M3U)
- Photoshop
- PICS
- PICT
- Pictures
- PNG
- QuickTime Image File
- QuickTime Movie
- SGI
- SMIL
- Sound
- Targa
- Text
- TIFF

- TIFF-fax
- Virtual Reality (VR)
- Wave

QuickTime also supports import of multiple images and layers in TIFF, FlashPix, and Photoshop files.

Export Formats

The following formats can be imported directly into the QuickTime Player (requires QuickTime Pro):

- AIFF
- AU
- AVI
- BMP
- DV Stream
- FLC
- JPEG/JFIF
- MacPaint
- MIDI
- Photoshop
- PICT
- Picture
- PNG
- QuickTime Image
- QuickTime Movie
- SGI
- System 7 Sound
- Targa
- Text
- TIFF
- TIFF-fax
- WAV

Video Effects

The following effects can be used in QuickTime-supported video applications (also in QuickTime Pro):

- Alpha gain
- Blur
- Color balance
- Color style
- Color tint
- Edge detection
- Emboss
- Film noise
- General convolution
- HSL balance
- Lens flare
- RGB balance
- Sharpen
- Zoom

Tools and Tasks

This section provides reference information about Apple's tools for creating, manipulating, and delivering QuickTime files.

QuickTime Pro

Go to www.apple.com/quicktime/products/qt

The QuickTime Pro upgrade for standard QuickTime allows you to work with 35 different file formats, performing basic editing, importing, exporting, and encoding tasks.

iMovie

Go to www.apple.com/imovie

iMovie 2 allows you to capture video from digital camcorders and perform basic editing, importing, exporting, and encoding tasks. You can also add titles, transitions, music, narration, and sound effects to create a finished movie.

Final Cut Pro

Go to www.apple.com/finalcutpro

Final Cut Pro combines professional editing, compositing, and special effects capabilities into one software package that utilizes DV and FireWire standards.

QTVR Authoring Studio

Go to www.apple.com/quicktime/products/qt

The QTVR Authoring Studio allows you to create 360-degree panoramic movies and virtual reality objects and to combine those elements into fully-functional immersive environments.

Additional Apple Resources

Visit the QuickTime Developers area at the Apple Website developer.apple.com/quicktime for knowledge base, documentation, tutorials, and other useful information.

You can find the additional resources shown in the following tables at the Apple QuickTime Web location (www.apple.com):

Table 2-11: QuickTime Streaming Tools

Tool	Platform	Description
RTSP/RTP Proxy	Mac OS, Win32	Used to give client machines within a protected network access to streaming servers outside that network.
QTPlayer Streaming Info	Mac OS, Win32	This plug-in adds an Info Panel for streaming tracks that shows packet transfer information.
QTStreamSplicer	Mac OS, Win32	This tool allows you to add an image to an audio-only live stream (or in front of a streaming track).
Hint Track Profiler	Mac OS	A diagnostic tool that graphs a streaming movie's hinted packets over time.

Table 2-12: QuickTime Webmaster Tools

Tool	Platform	Description
Plug-In Helper	Mac OS, Win32	Associates URLs as well as stores QuickTime plug-in settings inside a QuickTime movie.

Table 2-12: QuickTime Webmaster Tools (Continued)

Tool	Platform	Description
MakeRefMovie 2.1	Mac OS, Win32	Creates alternate movies for various Internet connection speeds, CPUs, languages, and more.

Table 2-13: QuickTime Effects Tools

Tool	Platform	Description
FlareMaker	Mac OS	This tool allows you to explore different Lens Flare effects for use in other applications.
MakeEffectMovie	Mac OS, Win32	Takes the video tracks from two movies and creates a new movie with an effects track for them.
Effects Teaser	Mac OS, Win32	This utility lets you explore the effects architecture in QuickTime.
MakeEffectSlideShow	Mac OS	Makes a slideshow movie that uses an effect to switch from one video track to the next.

Table 2-14: QuickTime VR Tools

Tool	Platform	Description
QTVR Edit Object	Mac OS	This tool allows you to set many parameters for QTVR Object movies such as column and row settings, pan and tilt controls, auto-play, and animate settings.
QTVR PanoToThumbnail	Mac OS	Allows you to create a small thumbnail-size linear QuickTime movie out of your QTVR panorama.
QTVR Flattenner	Mac OS, Win32	Lets you export Web-ready QTVR movies from QuickTime Player.
QTVR Converter	Mac OS, Win32	Converts between 1.0 and 2.0 versions of QTVR files using QuickTime Player's Export command.
QTVR Make Panorama 2	Mac OS	This tool allows you to create QuickTime VR panoramas from panoramic PICT images.

Table 2-15: QuickTime QD3D Tools

Tool	Platform	Description
3D Movie Maker	Mac OS	A tool for quickly creating QuickTime movie files that contain animated 3D models.

Table 2-15: QuickTime QD3D Tools (Continued)

Tool	Platform	Description
QD3D Viewer	Win32	Allows you to open and manipulate QuickDraw 3D files on Windows 95 and Windows NT systems.
QD3D Scrapbook	Mac OS	Lets you easily view and store text, pictures, movies, and 3DMF models in a scrapbook form.
QD3D to QTVR Converter for Panoramas	Mac OS	Converts QuickDraw 3D files into a sequence of frames that can be turned into QTVR panoramas.
QD3D to QTVR Converter for Objects	Mac OS	Lets you convert QuickDraw 3D files into a QuickTime VR Object using the 'QTVR Edit Objects tool listed in Table 2-14.
TextureEyes	Mac OS, Win32	Let's you apply any picture, movie, or video to the surface of a 3D object, paint on objects in 3D, or select different plug-in renderers.
3Debug	Mac OS	A debugging tool illustrating when and how 3D objects are managed within an application that tracks down possible memory leaks, and more.

Table 2-16: QuickTime Programmer Tools

Tool	Platforms	Description
Dumpster	Mac OS, Win32	Lets you view and edit moov (QuickTime Movie) resources.
HackTV	Mac OS, Win32	A basic movie capture tool that allows you to record audio and/or video.
Reinstaller3	Mac OS	Lets you drag a resource file onto Reinstaller 3 to destroy and re-register any components defined in the file.

Table 2-17: QuickTime Third-Party Tools

Company	Go To	Product
Adobe Systems, Inc.	www.adobe.com	Adobe Premiere, GoLive, After Effects

Table 2-17: QuickTime Third-Party Tools (Continued)

Company	Go To	Product
AutoDesk Inc.	www.discreet.com	EditDV, RotoDV, Cleaner 5, Media Cleaner Pro
Avid Technology, Inc.	www.avid.com	Avid Cinema, Avid Xpress DV, Avid ePublisher
Fidelity Media	www.megaseg.com	MegaSeg
Macromedia	www.macromedia.com	Flash
Media 100	www.media100.com	iFinish
MovieWorks Inc.	www.movieworks.com	MovieWorks
Pinnacle Systems	www.commotionpro.com	CommotionPro
Sorenson Media	www.sorenson.com	Sorenson Broadcaster
Totally Hip	www.totallyhip.com	LiveStage Professional, LiveSlideShow
Tribeworks	www.tribeworks.com	iShell

Before selecting a third-party vendor to provide services or products, you should conduct a thorough independent review of the third-party vendor's ability, skills, experience, and/or products to determine whether the third party can fulfill your particular needs.

Part C: Methods

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Choosing Your Technologies

When developing your own approach to streaming video and audio and when contacting service providers, you need to determine the following:

- Which encoding technologies will you use?
- Which media players would be best for your audience?
- Which server platform will you use?
- Will you deliver audio only or audio and video?
- Is your content short form or long form?
- Is your application in business, education, or entertainment?
- Will you provide on-demand, near-live, or live Webcasting?
- Do you require a distributed network solution or just a single unicast origination point?

Your answers to these questions will affect everything from your choice of development tools to your hosting services to your content options, as described below.

Which Encoding Technologies?

- Windows Media Technologies
- QuickTime
- RealNetworks RealMedia
- MPEG

This topic and the next (having to do with players and platforms) go hand in hand, since at the moment the owners of the player technologies all have their own streaming-video encoding schemes. Encoding technologies have advanced significantly in recent years. Those of us who began our multimedia careers with Cinepak can't help but be impressed with the current generation of video encoders from Real, Microsoft, and Apple.

By way of comparison, that 50 MB piece of video that once played off a CD-ROM at 180 kbps with Cinepak is now a 5 MB file that plays over the Internet using the Real Encoder at 18 kbps with similar quality. Amazing.

Experts can argue endlessly about the virtues of Real's encoder over Windows Media Technologies, over the Sorenson codec, but the truth is, they are all pretty close. By comparison with encoding technologies of the recent past, you can't lose. MPEG-4 is a factor that can shake things up a bit, but the standard and its implementation are still a work in progress.

For more information on the specific tools, see Part B: Tools on page 25. The truth is, whatever your choice, encoders are relatively low on the scale of technology factors you must consider when choosing delivery formats.

Amazon/DivX

Exhibit 1008

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More important are the underlying technologies used for getting the data from the server to the user's computer, which have a more profound impact on both the data rates at which you can encode and the quality of the end-user experience. Read on.

Which Players and Platforms?

- Windows
- QuickTime
- RealSystem

There are three angles on your choice of players and technologies to this: server-side, client-side (the end user), and development-side.

As a developer, first of all, which culture are you most comfortable with, Windows or Macintosh? Keep in mind that, in this day and age, development and testing of content for most streaming applications will involve both platforms, so the more agnostic you are, the better for your career in streaming media. However, if you have a preference and a set of tools on just one platform, you can simplify your life by focusing on testing and delivery for a single player.

Client-side, you need to consider the audience in your choice of players required to play the video. Are they all Windows users? Windows and Macintosh users? Mostly Mac?

Real, Windows, and QuickTime are all allegedly cross-platform, though common sense and experience suggest that consistent use of each vendor's products will yield fewer snags: RealServer with the RealPlayer (Mac and Windows), QuickTime Streaming Server with QuickTime (where there is a predominance of Mac users), Windows servers with Windows Media Technologies (often in business applications where Windows is ubiquitous).

As an interesting twist in this clash of the titans, Real and Apple recently announced that RealServer 8 will now support the QuickTime streaming format, which opens up opportunities for broader use of QuickTime streaming because there are far more RealServers deployed throughout the world than QuickTime Streaming Servers.

Apple and Windows both have the advantage of including their players with their respective OS software, although users must download and install players on the other platform (QuickTime on Windows or the Windows Media Player on the Macintosh). With RealPlayer, users must download and install the software on either platform if they haven't done so already.

Also, consider that the players themselves support different technologies beyond just video. For example, the QuickTime player supports Flash (SWF format), allowing you to mix video with animated Flash content. Both QuickTime and current versions of RealPlayer support the open SMIL standard for synchronizing video, audio, text, and graphics elements within the player. Most of us are used to thinking of these players as video-only vehi-

cles. You can find links to some fascinating real-world examples of these mixed-format presentations at the Real Website (www.reálnetworks.com) and Apple's QuickTime Web location (www.apple.com/quicktime).

Audio Only or Audio and Video?

This choice has a huge impact on deployment of streaming content as a result of the vastly different bandwidth requirements. If your presentation can do with audio only, depending on the length of the material, you can probably get by without a true streaming server and the associated expenses, distributing your content off a standard HTTP server.

Short Form or Long Form?

If video is a must, then you have the next choice to consider: Is the content short form (several minutes) or long form (10 minutes or greater)?

If your video is short form, consider HTTP streaming to deliver your video. Delivery via HTTP in the QuickTime progressive video format, for example, allows you to avoid the added expense of setting up or renting space on a true streaming video server.

HTTP streaming is great for short movies and anything else you intend to play over and over again. The trailer for the *Star Wars* prequel in 2000, for example, was one of the most successful downloads of all time.

In addition, consider that the QuickTime progressive format is not lossy but results in a complete frame-accurate download. The AvidProNet Review & Approval technology, for example, leverages this added accuracy of the progressive download.

Real-time streaming, on the other hand, is a must for full-length movies, lengthy presentations, and live events. In addition to meeting the unique throughput and storage demands of long-form viewing, real-time streaming technologies make it easier for viewers to navigate randomly throughout a long program, another important feature to keep in mind. Navigating randomly in a progressive video download involves long waiting times when moving to a section that has not yet been downloaded.

Which Market: Business, Education, or Entertainment?

The type of content you are delivering also affects your technology requirements. If you are developing business applications, such as corporate training or presentations, then you might not need to spend the money on an expensive distributed network solution, because most businesses already operate close to high-speed Internet backbones, using T1 or T3 lines. If you have the budget, however, and want to use higher-quality video at higher data rates, delivery at the edge is still an option.

If you are delivering distance-learning content to higher-education institutions, the same situation applies. Most colleges are closely linked to a high-speed backbone, and some are part of the Internet2 experiment, making distributed networking solutions unnecessary.

For entertainment, this usually means reaching a mass audience, and depending on the performance requirements and reach of your project, a distributed network solution might be necessary. Apple's close connection with Akamai is a good example of a solid marriage between streaming entertainment content and delivery technology.

On-Demand, Near-Live, or Live Webcasting?

On-demand Webcasting is the most common form of streaming, allowing any combination of users to access the streams whenever they like. On-demand Webcasting is subject to the requirements described in the previous topic.

Live Webcasting is a whole other animal and usually requires significant support from third-party distributed network service and technology providers to handle large audiences. Visit www.netaid.org for more information on the technologies used to deliver the largest live Webcast in history.

Video Preparation Tips

Here are a few tips to keep in mind when shooting video that you will encode for streaming on the Web:

- Shoot on a high-quality format, with the best equipment available. Professional cameras using broadcast-quality tape formats such as BetaSP or Digital Betacam are the best option, followed by prosumer DV formats.
- Make sure the subject is well lit.
- Avoid frequent or rapid movements whenever possible.
- Keep the camera steady as much as possible.
- Closeups generally encode better than wide complex shots.

Here are a few tips to keep in mind when capturing video that you will encode for streaming on the Web:

- If you recorded in a consumer format, consider using an industrial playback deck that has a TimeBase Corrector (TBC).
- Keep your signal transfer path as clean as possible. Use a DV FireWire connection for DV video or an S-Video connection rather than composite RCA jacks whenever possible.

Here are a few tips to keep in mind when preparing captured video clips for encoding:

- **Name the clips.** For the greatest cross-platform compatibility, be sure to name your movie in a way that does not confuse the Web server's file system, the client computer's file system, or the Web browser. Remove spaces and special characters from filenames; consider making the names lowercase. Make sure to include the proper extension.
- **Make movies self-contained (QuickTime only).** For prerecorded movies, you'll need to decide whether you want to stream self-contained movies or movies that contain dependencies. Self-contained movies contain all the information for that movie within the movie file. Movies with dependencies contain references to the media tracks in other movies, which would also have to be on the server. Self-contained movies are easier to handle — there's only one file to worry about.
- **Hint movies (QuickTime only).** Prerecorded and live QuickTime movies must be hinted for streaming. This means creating a hint track for each media track in the movie (except for QuickTime VR and Flash tracks, which cannot be streamed). The hint tracks, which are stored in the movie along with the video, audio, and other tracks, provide QuickTime Streaming Server software with information about the server, the transmission packet size, and the protocol to be used — in short, how to send the movie data over the network.

Encoding Methods and Target Rates

Topics in this section describe the encoding process, with tips and techniques for producing the best possible results at both low and high data rates.

On-Demand Encoding Workflow

The workflow for encoding on-demand content is roughly the same in all of the big three formats, no matter the output:

- Choose the source.
- Choose the encoding parameters, based on default or customized templates.
- Choose the destination.
- Start encoding.
- Where the three formats differ most is in the postencoding phase prior to deployment, or what is sometimes called late-stage editing. Basic late-stage procedures such as hinting of QuickTime files and preparation

of scripts are described in “Late-Stage Editing” on page 64. Additional information on adding URL flips, manipulating tracks, and enabling various multimedia features are described in Chapter 5, Synchronized Media.

- If you use Cleaner to encode your content, you can accomplish a number of basic late-stage editing tasks, such as adding URL flips, during the encoding phase. For more information, consult the Cleaner documentation.

Live Encoding Workflow: Similarities and Differences

The workflow for encoding of live content is similar among the big three formats, with a few differences:

- Carefully set up the live encoding environment from source to output. This includes establishing connection from the source camera or live switcher (when there are several cameras) to the encoding workstation, from the encoding workstation to a streaming server over a high-speed IP network, and from the server to a multicast backbone (MBone), or in some cases from the streaming server to a distributed network of servers when you must reach a national or international audience. Optionally, a third computer is set up to act as a unicast reflector to stream out to areas of the Web not accessible through an Mbone. Some or all of these connections are usually established with the aid of a distributed network service provider.
- Prepare the necessary broadcasting software for live encoding. In the case of Windows Media and RealSystems, live encoding can be accomplished using the same software used to encode on-demand material — specifically, Windows Media Encoder or RealProducer. In the case of QuickTime, live encoding requires Sorenson Broadcaster (available from Sorenson Media; visit www.sorenson.com). The encoding software must be properly configured for live encoding prior to the live event. Use the broadcast software to create a session description protocol (SDP) file on the computer you use to capture and encode the live signal. See the instructions that came with your broadcast software.
- With all systems in place, turn on all devices, open the encoding software, and perform all necessary checks. Copy the SDP file to your streaming server. Be sure to copy the file into the media folder you’re using for streaming. If it is not there, streaming will not happen.
- If you want the streamed media to show on a Web page, set up the Web page.
- Make sure streaming services are started.

- Start the capture software by following the instructions that came with the broadcast software.

Effective Encoding Environments

To encode your clips, you need to establish an encoding system using a capable computer along with software tools described in Part B of this chapter. You can encode using the tools provided by the software manufacturer (Microsoft, Apple, or RealNetworks), or you can encode on-demand material using a third-party tool, such as Cleaner from discreet. Various editing products also allow you to encode directly from the application using either plug-ins from the streaming software manufacturer or third-party plug-ins such as Media Cleaner EZ.

Here are some factors to consider when establishing your encoding environment:

- Use the fastest computer available. Encoding is CPU-intensive, but not memory-intensive. The more processing power your system has, the faster your clips will encode.
- Devote the system to the encoding task. Because encoding is CPU-intensive, the less activity that takes place on that system during encoding, the faster it will encode. Encoding live data is the most processor-intensive, so certainly make sure you have a dedicated encoding station during a live Webcast.
- Configuring Microsoft Windows. If you are planning to use Microsoft Windows NT Server instead of Windows NT Workstation, we highly recommend that you change the system setting to reduce the amount of memory that is used for caching files. Otherwise, Windows NT Server attempts to expand the file cache at the expense of Windows Media Encoder. The result is that the encoder gets paged out and falls behind when capturing data from the audio device. The settings for this preference can be found by clicking start > settings > control panel > network > services.
- Standard CPU monitoring tools, such as Microsoft Performance Monitor, cannot precisely measure the CPU load of the encoder because they are not able to show the instantaneous CPU peaks that last just a few milliseconds. When there is high motion in the video, the CPU load can exceed what is available for just one frame time (33 milliseconds at 30 fps), which causes a frame of video to be lost. Such peaks are impossible to observe with a performance monitor that shows average CPU usage over time.

Encoding Target Rates

With streaming media, it's all about bandwidth. No amount of effort can overcome the basic limitations of the pipes. Most encoding software includes templates that take into account the hard realities of the public network and choose the appropriate data rates for you. If you use the manufacturer's templates, in most cases you can't go wrong.

For added control, you can click on the Encode tab in the Cleaner 5 interface or dig more deeply into the manufacturer's encoding software to adjust these data rates directly. In most cases, this is not necessary. In some special cases (for example, when you want to boost the data rate of the audio significantly and reduce the video rate to give priority to sound quality), you can make these changes. Table 2-18 provides a general overview of appropriate data rates to maintain for the various delivery methods.

Table 2-18: Streaming Media Encoding Data Rates

Delivery	Network Data Rate	Aggregate Encode Rate — True Streaming	Aggregate Encode Rate — HTTP Streaming
28.8 modem	28 kbps	20 kbps	17 kbps
56k modem	56 kbps	32 kbps	26 kbps
Single ISDN	64 kbps	48 kbps	45 kbps
Dual ISDN	128 kbps	96 kbps	90 kbps
DSL	64 to 128 kbps	48 to 96 kbps	45 to 90 kbps
Cable modems, low end	100 to 256 kbps	80 to 225 kbps	76 to 210 kbps
Cable modems, high end	256 to 512 kbps	225 to 450 kbps	210 to 420 kbps
Corporate LAN	150 kbps	110 kbps	100 kbps
Gigabit Ethernet network	1500 kbps	1100 kbps	1000 kbps
Local drive	300 to 1,500 kbps	250 to 1,400 kbps	N/A

Tips for Creating Low Bit-Rate Video

Most streaming media professionals consider a 56K modem to be the minimum connection for delivery of any kind of meaningful user experience. If you've ever attempted to view streaming video from home with a 56k modem (or worse, a 28.8 modem), you know that the phrase "good-quality low-bandwidth streaming video" is an oxymoron, not to mention a mouthful.

Creating good-quality video for low-bandwidth situations is not a lost cause. You can make the best impression by paying close attention to these five factors: the quality of the source material, the type of content, the frame rate, the sound and image quality settings, and the image size settings.

To ensure the best-looking content at 56K modem rates or lower, consider making these hard decisions:

- Edit out all motion.
- Edit out all detailed wide shots.
- Drop your frame rate to as low as 10 or 8 fps.
- Encode stereo audio as mono.

If you must deliver streaming content to 28.8 or (gasp!) 14.4 modems, consider delivering audio-only, or when images are necessary, consider showing a single still image of the speaker when the content is simply a talking head or creating a slideshow that combines audio with a series of still images-

Tips for Creating High Bit-Rate Video

At the opposite end of the spectrum is high bit-rate video for delivery in controlled circumstances, such as over a high-speed LAN or a very fast cable-modem system.

Realistic data rates for so-called broadband streaming in various circumstances are listed in Table 2-19.

Table 2-19: Streaming Media Broadband Data Rates

Delivery	Network Data Rate	Aggregate Encode Data Rate
DSL	100 to 256 kbps	80 to 225 kbps
Cable modems, low end	100 to 256 kbps	80 to 225 kbps
Cable modems, high end	256 to 512 kbps	225 to 450 kbps
LAN	150 kbps	110 kbps
Local drive	300 to 1,500 kbps	250 to 1,400 kbps

The rules for producing good-quality high bit-rate video are the same as for low bit-rate content, but because the receiving systems must process more data in the same amount of time, you should be reasonably certain that your audience is using modern computers, with CPU speeds of 300 MHz or greater.

High-end broadband video delivery is relatively new, and therefore most encoding software packages do not include templates covering broadband delivery in the very high range, for local playback or playback over a gigabit Ethernet network, for example.

Windows Media Encoder 7, for example, covers bit rates up to 1,500 kbps, while RealProducer 8 templates go up to 512K cable/DSL/LAN rates. To achieve higher rates, you must create custom templates and make adjustments.

Here are a few tips to keep in mind when creating your broadband encoding templates:

- To reduce the CPU requirements on the client, you can change the audio codec setting to mono.
- Avoid selecting too high a data rate for the audio portion of your stream because it increases both the encoding and decoding processing requirements of the system.

Setup of Multiple Bit-Rate Video

All of the big three formats allow you to set up your video streams so that users receive the one stream that is appropriate for their particular bandwidth. Although your Web location might show a single link to the video, for example, behind the scenes the video technology is able to choose among several video clips encoded at different rates, based on the user's connection speed.

This process of setting up multiple bit-rate video works differently, depending on your choice of streaming video technology:

- RealSystem employs the SureStream technology developed by RealNetworks. SureStream is included as part of RealServer software. Real's templates include SureStream options for encoding multiple streams. No further steps are necessary once the video is encoded and deployed on a RealServer. The RealServer software automatically calculates the user's connection speed and delivers the appropriate media stream.
- Windows Media Technologies employs Intelligent Stream technology developed by Microsoft. Intelligent Stream is included as part of Windows Media Services whenever you set up streaming on a Windows server. Windows Media Technologies templates include Intelligent Stream options for encoding multiple streams. No further steps are necessary once the video is encoded and deployed on a Windows media server. The server software automatically calculates the user's connection speed and delivers the appropriate media stream.
- QuickTime uses a different system for handling multiple bit rates. The QuickTime control panel includes an option for setting the connection speed of the client computer, which users choose when they first install

QuickTime. Content creators must then set up a QuickTime Reference movie that includes references to multiple bandwidth QuickTime streams. The reference movie is able to determine the connection speed settings on the client computer and deliver the appropriate stream.

- Although the QuickTime implementation requires more effort on the part of content creators — and involves the possibility of user error in entering the wrong connection speed into the QuickTime settings — there are also some advantages to this system. For example, this implementation works even when delivering movies from an HTTP server, which makes QuickTime a strong choice for delivery from a standard Web server. You can also use this feature to handle backward-compatibility or to switch among streaming and nonstreaming content based on the user's settings.

Late-Stage Editing

Where the big three streaming formats differ most is in the postencoding phase prior to deployment, or what is sometimes called late-stage editing. Basic late-stage procedures such as preparation of reference movies and scripts and hinting of QuickTime files are described in this section. Additional information on adding URL flips, manipulating tracks, and enabling various multimedia features are described in Chapter 5, Synchronized Media.

Creating QuickTime Reference Movies

When streaming QuickTime video at multiple bit rates, you must use a QuickTime Reference movie to allow the system to intelligently switch among bit rates based on the user's connection speed. The easiest way to create QuickTime Reference movies is with Cleaner or Media Cleaner Pro. The Cleaner documentation describes a procedure for encoding multiple bit-rate video clips and generating a single reference movie along with the encoded clips automatically.

If you do not have Cleaner and must create a QuickTime Reference movie on your own, you'll need the Pro version of QuickTime Player and an application that allows you to make a reference movie, such as Peter Hoddie's XMLtoRefMovie utility or Apple's free MakeRefMovie utility. To make a reference movie using Apple's utility, do as follows.

Make the alternate data rate movies:

- If some of your alternates are streaming movies, make Fast Start movies that point to them, and use the Fast Start movie as the alternate for the stream.
- To create a Fast Start movie that points to a streaming movie, open the streaming movie in QuickTime Player by choosing Open URL from the

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File menu and typing in the URL. Then choose Save As from the File menu, name it, and save it as a self-contained movie.

- Also create a default movie that anyone in your audience can see, no matter what connection or computer they are using. It could be a few frames from your movie with a low-bandwidth audio track, a single image with a scrolling text track and no audio, or just a single image. In any case, keep it very small because the browser will download it even if an alternate movie is used.
- Name each movie in a logical way, including the .mov filename suffix. For example, you may want to name your alternate movies `altmov01.mov`, `altmov02.mov`, and `altmov03.mov`. Save as self-contained movies. Store them all in the same folder or directory.

Make the reference movie using Apple's free utility program MakeRefMovie, available from Apple for Macintosh and Windows. The latest version of MakeRefMovie can also create reference movies that choose among alternate movies based on CPU speed, language, or QuickTime version.

Follow these steps in MakeRefMovie:

1. Open MakeRefMovie.
2. Save your new document in the same folder or directory where the alternates are located. Make sure the reference movie filename contains the .mov extension. This reference movie will call upon the alternates.
3. Drag each of the alternate movies onto the window of MakeRefMovie. An alternate movie will appear for each file you drag and drop. Or you can open each file separately by choosing Add movie file from the Movie menu.
4. Set the minimum connection speed for each alternate movie in the Speedpop-up menu.
5. Set the load order of the movies in the Priority: pop-up. For example, you may want the reference movie to call the highest-quality movie first, then the medium-quality movie, and last the lowest-quality or default movie. If there is more than one movie designed for the same connection speed, set a priority for which movie will load first.
6. Specify the default movie by checking Flatten into output. The default movie should be compressed with a codec supported by older versions of QuickTime for backward compatibility. This checkbox can only be applied to one movie.

Save the reference movie and place it and all the alternate movies in the same directory. Upload the directory or folder to the server.

Hinting QuickTime Movies

Before you can stream an existing QuickTime movie using QuickTime Streaming (from an RTP server), you must Hint it.

Hinting is the QuickTime term for adding instructions to a movie that tell the streaming server how to break the file into tiny packets of data that are sent over the Internet. Hinting also instructs the server when to send a given packet.

The easiest way to hint a movie is by using Cleaner 5 or Media Cleaner Pro. Use the Prepare for Streaming Server option in Cleaner's Advanced Settings dialog.

If you do not have Cleaner, you must hint each movie that you intend to stream on your own using the QuickTime Player:

1. Begin by opening a movie in QuickTime Player by either dragging the movie onto the application icon or launching QuickTime Player and choosing Open Movie... from the File menu option.
2. Choose Export from the File menu.
3. In the Export dialog box, enter a filename with the .mov extension, and from the Format pop-up menu, choose Movie to Hinted Movie.
4. Choose Default Settings from the Use pop-up menu.
5. Click Save to create a hinted movie, or click the Options if you wish to fine tune the hint settings.

Caution: Only those authors with advanced expertise should change the defaults as this may cause poor performance and quality of the stream.

Deployment with HTML

The simplest way to deploy your content is to prepare links on a Web page that cause the player on the client's computer to open and load the video. By simply adding a standard HREF tag into your Web page with a link to the video clip in its location on the server, you are on your way. As mentioned earlier, you must link to a QuickTime Reference movie, in the case of QuickTime.

You can also embed players into Web pages using HTML code that employs Netscape plug-ins or ActiveX Objects to achieve greater control of the user experience. Tools and methods for embedding players and developing interactivity with other elements on the Web are described in Chapter 5, Synchronized Media.

Enhancing Players with Scripting

You can improve the viewer experience, and improve your own workflow as a content creator to some extent, by delving into the various supported script

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technologies used to add features to the various video players. Each of the big three players supports different script technologies for achieving a variety of results:

- QuickTime: SMIL, JavaScript, AppleScript
- Windows Media Technologies: ASX scripting, JScript
- RealSystem: SMIL, JavaScript

Some of these capabilities are described in more detail in Chapter 5, *Synchronized Media*.

Deployment Challenges

For simple deployment of streaming video, the basic steps are:

1. Upload the video content to the streaming server.
2. Upload the HTML files containing links to the video to the HTTP server.

Many of the applications described throughout this chapter, such as Cleaner, Windows On-Demand Producer, and RealProducer will do these steps for you automatically after encoding video.

The real challenges of deployment come when seeking to optimize both the hardware and software used to deliver streaming media effectively. The following sections describe a few tips for achieving effective streaming.

The Server

The configuration requirement for the server platform differs depending on whether the content is being streamed live or on demand. Specifically, if the server platform is streaming on-demand content, you must plan on having a high-performance disk subsystem. When streaming live content, the performance of the disk subsystem is not a factor. Also note that a single server can stream out about 50 to 70 Mbps (over a 100-megabit network card). If you have to go beyond this limit, you must use a cluster of servers with some type of load-balancing software.

Once the performance of a single CPU server (about 30 Mbps to 50 Mbps) is exceeded, you should consider using a cluster of computers and load-balancing software.

Microsoft Windows Load Balancing Service (WLBS) allows clustering of TCP/IP-based network services across up to 32 computers, which then appear as a single logical TCP/IP address space. WLBS complements Microsoft Cluster Service (MSCS), which is part of Microsoft Windows NT Server, Enterprise Edition. You can also use a multiprocessor system to increase your throughput, although this creates a single point of failure and is not as reliable as a clustered system.

New servers are appearing in the market to handle the specific needs of streaming media. For example, the Trilligent Cluster systems from Avid Technology, Inc., can achieve extraordinary streaming data throughput and are easy to manage. Monitoring on Trilligent Cluster also allows service providers to track performance of the system. Both RealServer and Microsoft Windows Media Services include a number of performance counters that you or your service provider can use to track performance.

The Client

The requirements for your audience — the client computers — vary depending on the bit rate, video frame size, and frame rate. The most important requirement is a high-performance graphics card followed closely by a high-performance CPU.

The following list shows the minimum client configuration for data rates up to 250 kbps:

- CPU speed of 166 MHz or greater
- 32 MB of memory

If you provide content at bit rates higher than 250 kbps, use the following client configuration — this client computer performs well for data rates of up to 2 Mbps:

- CPU speed of 233 MHz or greater
- 64 MB of memory
- High-performance graphics card

For a client computer that supports the highest data rates, use the following specifications:

- CPU speed of 400 MHz
- 64 MB of memory
- High-performance graphics card

Using Distributed Networks

As described in the section “Taking It to the Edge” on page 21, a number of service providers exist for distributing your streamed content around the world and are closer to users so that the effectiveness of streaming is greatly improved. Networks such as Akamai and RealNetworks provide these services.