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# Choosing a Web Video Codec

White Paper

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## INTRODUCTION

By leveraging the power of Internet-based video delivery, you can extend the reach and increase the ROI of your media assets. Whether you are using the Internet to distribute interactive, video-based brand extensions of your hit television series or sharing critical business information via your corporate intranet, it is vital that your content make a good impression. For video content delivered over the web, good impressions are the result of perceived quality. And while compelling content can transcend technical imperfections, there's a lot to be said for content that looks and sounds great.

A host of factors contribute to the perception of quality, including lighting, camera angles and motion, audio levels and clarity, color consistency and so on. Viewer expectations, too, depend on the nature of the content. Consumers, for example, expect exceptional quality when watching feature film trailers or episodes of their favorite television shows online, whereas viewers are more likely to be forgiving of breaking news footage shot with a low-resolution, video-enabled cell phone. In other words, when describing web video, "quality" is a relative term defined by context.

H.264 and VC-1 are currently the most popular web video codecs. Apple QuickTime Player and Adobe Flash Player technologies support H.264, while Microsoft Windows Media Player technologies support VC-1. H.264 and VC-1 can scale to accommodate delivery across the entire bandwidth spectrum, and both codecs can deliver high-definition content at full-screen resolutions when combined with a broadband connection, a modern CPU and hardware acceleration.

But what if your target audience doesn't have access to broadband connections and the latest CPUs? Flash, QuickTime and Windows Media provide a number of codec alternatives to choose from. This document provides a high-level overview on how to select an appropriate codec based on your content, target platform and business considerations. Irrespective of the formats and codecs used during capture and editing, the choice of delivery codec plays a crucial role in the viewing experience.

Footage of action sports, for example, will benefit from a codec that can handle high-motion content. Medical imaging used in collaborative distance surgery calls for a codec that can run in real-time and reproduce ultra-fine details without introducing artifacts.

Other types of content may be less demanding. Tutorial footage that explains how to use a particular piece of software, for example, might be perfectly acceptable if encoded using a screen capture codec optimized for low bit-rate delivery. As the popularity of MP3 audio files has demonstrated, there is plenty of room in the market for "good enough" compression.

In some cases, business concerns might be as much or more of a priority as excellent image and audio quality. Security, for example, could be of paramount importance to a corporate officer delivering a briefing to the financial community or to a film production company posting dailies online for studio executives and other stakeholders to review and approve. In these examples, your codec choices will likely be driven by your choice of playback platform.

Prevailing bandwidth conditions also have a profound effect on the viewing experience, so codec choices must accommodate available bandwidth. High-definition, full-screen web video, for example, requires that an audience have broadband Internet connections to be effective. Broadband connections, however, are not yet ubiquitous, so using a codec that is scalable and highly efficient can help mitigate issues that arise from disparate connection speeds and playback capabilities.

Another factor that must be taken into account when choosing a web video codec is how efficiently it can be decoded. Popular codecs offer highly sophisticated filtering, motion compensation and other powerful compression features that stress all but the most up-to-date computers. It is important, therefore, to consider your target audiences' computing capabilities. This task is easier for enterprises that equip their personnel with a standardized computing platform. Anyone trying to reach a mass-market audience over the web must take a least-common-denominator approach or deliver versions of their content scaled for low, medium and high bit-rate playback.

These factors also come into play when choosing an appropriate transmission mode, which typically means either progressive download or real-time streaming. Which mode you choose will have ramifications across your compression workflow from encoding through delivery.

Fortunately, the dominant web video formats — **Adobe Flash, Apple QuickTime, Microsoft Windows Media** — support **H.264** and **VC-1**, two codecs that are virtually indistinguishable from each other at high bit-rates. The differentiating factors are found in subtle but important details — post-processing filtering features, the installed base of playback platforms (media players and browser plug-ins as well as compatible operating systems), security features, digital rights management capabilities and so on.

Delivering individual video files in whatever web video codec and format you choose is often simply a matter of outputting your content in that format from your nonlinear editing system. Encoding on a larger scale requires scalable, high-performance universal media transcoding technology such as Rhozet™ Carbon Coder™ and Carbon Server™.

## WEB VIDEO HISTORY

The shape of web video has always been dictated by prevailing bandwidth conditions and available CPU horsepower. In the early days of web video (circa 1995), most consumers accessed the Internet over limited-bandwidth dial-up connections using 28kbps or 56kbps modems. High-speed access was typically only available in corporate environments where T1 or T3 lines were shared among hundreds of employees. Computers as a whole were much less capable than they are today.

As a consequence, web video of the mid-1990s was often delivered as a downloadable file, which could only be played after it was completely downloaded to a user's computer. QuickTime and MPEG-1 were popular codec and format choices, because they could deliver acceptable quality (for that time) at low bit-rates and low resolutions. Such video played back at screen sizes that were essentially on par with that of a modern video iPod — 320x240 pixels — or smaller. Fortunately, modern codecs are much more efficient than older codecs, so they deliver much higher quality than older codecs at comparable data rates.

While broadband access has become pervasive enough for most North Americans and Europeans to take it for granted, it is important to remember that in some developing countries — South Africa, for example — dial-up modems are still prevalent.

## TRANSMISSION MODES

The two most popular forms of transmitting video over the web today are **real-time streaming** and **progressive download**, each with its drawbacks and advantages. Flash, QuickTime and Windows Media are all capable of both types of transmission.

### Real-time Streaming

Real-time streaming is often employed for transmitting content that is longer than about 10 minutes. To accomplish this, specialized streaming server software is required. Windows Media streaming requires server software that supports the MMS (Microsoft Media Services) protocol. QuickTime utilizes RTSP (Real Time Streaming Protocol), while Flash uses RTMPE, an enhanced version of Adobe's Real Time Messaging Protocol (RTMP). Many corporate firewalls block streaming protocols, so the major streaming solutions are able to fall back to TCP or HTTP transmission. Streaming is generally considered more secure than progressive download, but each of the major formats and their respective media players boast some form of content protection for both streaming and progressive download files.

### Progressive Download

Progressive downloads can be transmitted using standard web protocols such as HTTP and FTP that don't require special servers for delivery. Progressive transmission lets you control video and audio quality at any connection speed. The tradeoff is that playback does not occur in real time.

Most progressive download files can be set to automatically start playing after a certain amount of the content has been received. In scenarios where the duration of the content is short enough, the file will finish loading before playback catches up to the download. This gives the user an experience that mimics streaming. It's more common for progressive files to be of sufficient length that playback catches up to what's been preloaded in the buffer, causing viewers to wait for the buffer to fill before playback continues. In practice, progressive downloads for files that are longer than about 10 minutes can be problematic from a viewer-experience point of view.

Similarly, so-called "Instant-On" or "Watch Instantly" streaming allows video to begin playing by reducing buffering/wait time. Instant-On experiences require broadband connections. File sizes and therefore appropriate data rates for the available bandwidth are crucial, as is the choice of codec. All three of the major formats, Flash, QuickTime and Windows Media, support this function using their respective server and player technologies.

Non-real-time playback has another benefit — two-pass variable bit rate (VBR) encoding can be used to improve video and audio quality. Most codecs function in one-pass mode, compressing the file as it is being read. Some one-pass codecs run at a constant bit rate (CBR). Other codecs offer one-pass VBR, where the data rate can vary over time, resulting in better average quality. Two-pass VBR codecs use one pass to measure the relative complexity of the content. On the second pass, the codec applies the available bits over the entire file to achieve the highest average quality, spending more bits on complex sections and fewer bits on less demanding sections. This technique produces substantial gains in compression efficiency over CBR and one-pass VBR methods.

### Multicasting

Multicasting is a variation on real-time streaming in which multiple viewers can watch the same content at the same time. Multicasting is used for capturing, compressing and storing as well as webcasting live events in real time. Multicasts require that every router between the server and each client be multicast-enabled. Again, all three of the major formats support multicasting, as do most modern routers, but the function isn't always turned on. The benefit of multicasting is that a multicast stream preserves overall network bandwidth and can be useful for transmitting over low-bandwidth LANs. Intra-company communication and distance learning are two common uses for multicasting.

Quality-of-service issues can arise with both streaming and progressive download content. Web video is delivered in packets. What happens when a packet is dropped or corrupted during transmission is an area each of the major formats handles differently. Viewers expect a seamless, trouble-free viewing experience when watching certain types of content — especially content they paid for. Any interruption of service could dissuade customers from remaining customers.

## BUSINESS CONSIDERATIONS

Business considerations begin with a fundamental question: “Can your audience watch your web video?” Streaming high-definition content over a corporate intranet might seem like an ideal way to use great looking video to deliver a message to everyone in your company, but there are myriad factors that could torpedo the experience, including:

- Insufficient network bandwidth
- Content data rate and user connection speed mismatch
- Underpowered client-side computers that cannot decode the content data stream
- Users don't have a compatible browser plug-in or media player installed.

In context of the Internet at large, these factors still apply and are compounded by things over which your IT department has no control. An in-depth discussion of the possibilities is beyond the scope of this document, but it is essential to understand the typical computing power, available connection speed and operating system(s) your target audience is likely to be using. Your task may be simpler if you are only trying to reach a crew of early adopters running the latest computers on a single operating system, although using an enterprise-level transcoding system such as Rhozet Carbon Coder makes short work of delivering content in each of the major formats as well as in various legacy formats at a variety of resolutions and data rates.

## BRAND, CONTROL, TRACK AND MONETIZE

Flash, QuickTime and Windows Media can be played back in their respective media players or through browser plug-ins. The appearance of each of the available media players can be customized, allowing companies to deliver branded experiences to their customers. The Apple QuickTime Player and Microsoft Windows Media Player are available for both Macintosh and Windows operating systems. Both can be given custom skins. Adobe and Microsoft offer next-generation playback technologies — Adobe Media Player and Microsoft Silverlight, respectively — that are runtime-environments on which custom applications can be written to deliver a wide variety of interactive experiences.

The ability to maintain strict control over access to content, track viewer behavior, capture vital statics and monetize content in various ways are must-have capabilities for some enterprises. These capabilities are another area where there are significant differences between what each of the major web video formats brings to the table.

Adobe Media Player combined with Flash Media Server 3, for example, enables new revenue generation models including advertising that can be refreshed dynamically even after the content has been downloaded to a user's computer, subscription-based delivery that requires authentication on a per-user or group basis, and more.

Microsoft Silverlight supports Microsoft PlayReady DRM content protection and offers developers a programming environment for delivering rich media experiences including streaming video on demand (VOD), protected downloads and much more. Adobe Media Player and Microsoft Silverlight are cross-platform applications that run on Windows and Mac OS.

## PROTECTIVE MEASURES

Technology to restrict unauthorized use or distribution of content is an essential ingredient for many businesses. Most computer-based content protection systems use a combination of a license server and public key encryption, which ties specific content to a specific machine or device. These encryption methods reduce but do not eliminate piracy, because all broadly deployed technologies have been beaten. The digital rights management technologies used in the major web video formats are:

**FairPlay** (Apple, iTunes, iPhone and iPod specific). FairPlay-protected files are regular MPEG-4 container files with an encrypted AAC audio stream. FairPlay does not prevent a file from being copied, but rather controls the conditions under which it can be decoded and played back. FairPlay is built into the QuickTime architecture.

**Flash DRM** (Adobe, Flash specific). The Flash DRM supports encrypted streaming and protected downloads, and enables content licensing as well as limited usage or download-to-own delivery models.

**Windows Media DRM** (Microsoft, Windows specific). The WM DRM supports direct and indirect licensing, subscription services, pay-to-download and rental services, as well as VOD and pay-per-view models.

## FORMATS AND SUPPORTED CODECS

The following is a look at each of the major formats and the codecs they support as well as a breakdown of the types of content for which they are best suited. While some of the formats support numerous codec options, H.264 has become the video codec of choice for both QuickTime and Flash. VC-1 is Microsoft's primary video codec, but the company has announced support for H.264 in an upcoming version of Silverlight.

### H.264 vs. VC-1

H.264 and VC-1 are both industry standards. However, just because a technology supports one of these "standards," it doesn't guarantee compatibility, because H.264 and VC-1 consist of many different "Profiles" and "Levels."

A **Profile** defines a subset of features needed to support a specific delivery platform. A **Level** specifies constraints within a Profile, such as maximum resolution or bit-rate. H.264 Profiles appropriate for web video applications are: Baseline Profile (BP) for limited computing power and Main Profile (MP) for typical consumer computers. For VC-1, your choices are Low and Main Profiles at low, medium and high levels depending on target platform.

At high bit-rates, the differences between H.264 and VC-1 are subtle:

- Under high bandwidth stress, H.264 tends to degrade to softness instead of blockiness, whereas VC-1 tends to retain more detail, but can show more artifacts due to its stronger in-loop deblocking filter. At web/download bit-rates, both codecs offer great quality.
- VC-1 has an optional post-processing filter that can be used to reduce artifacts when sufficient CPU horsepower is available. This filter is implemented in Windows Media Player.

- H.264 tends to take more CPU power to decode at maximum complexity. Comparing VC-1 Advanced Profile and H.264 High Profile, each with all of its options turned on, VC-1 can decode about twice as many pixels per MIPS. This has more bearing on HD-resolution content than lower resolution content and doesn't matter at all when there's a hardware decoder. When constrained by software decoder performance, VC-1 can handle Advanced Profile, while H.264 is limited to Baseline, where VC-1 outperforms H.264 in quality/efficiency. This has become an important consideration in recent years, because consumer broadband access has outpaced the hardware upgrade cycle of many households and businesses.

For audio associated with H.264 video files, Advanced Audio Coding (AAC) is the predominant audio codec, although Flash and QuickTime implement different flavors of AAC. QuickTime, for example, implements AAC-LC (Advanced Audio Coding Low Complexity). The Flash implementation of AAC supports HE-ACC v2, which is also known as HE-AAC+. HE-AAC v2 extends AAC by applying spectral band replication (SBR) and parametric stereo (PS) techniques to increase coding efficiency at low bit-rates. Microsoft's Silverlight implementation of AAC will initially be for AAC-LC.

### Flash (Adobe Systems, Inc.)

In its original incarnation, Flash was a small-footprint compression format designed for delivering animation over low bit-rate dial-up connections. Flash Player 6 introduced video streaming using Macromedia Flash Communications Server MX. Sorenson Spark was the codec. Spark was a moderately efficient codec based on H.263. Progressive download was added with Flash Player 7, and support for the On2 VP6 codec was added in Flash Player 8. As of Flash Player 9, the primary video codec is AVC/H.264, aka MPEG-4 Part 10. Audio support includes the audio codecs defined by MPEG-4 Part 3 — AAC Main, AAC-LC and HE-AAC v2.

Adobe offers two media player technologies: Flash Player and Adobe Media Player. Flash Player is a browser extension which, according to a study conducted by Millward Brown<sup>1</sup> for Adobe, is installed on 99% of all Internet-connected computers. Flash Player runs on a variety of operating systems including Windows, Mac OS and Linux. Flash Player supports playback of Flash Video (FLV) and ShockWave Flash (SWF) files as well as MPEG-4 (MP4/F4V) content when a user is online. Adobe Media Player is a desktop application that runs on Windows and Mac OS and supports playback of streamed or downloaded FLV and MPEG-4 content when users are online or offline.

### Flash Video Codecs

H.264/AVC, also called MPEG-4 Part 10, is a highly efficient codec designed to produce better quality at substantially lower bit-rates than older codecs such as H.263 and MPEG-1. Flash supports the following profiles: Baseline, Main Profile (MP), High Profile (HiP), and High 10 Profile (Hi10P). Baseline applications include video conferencing and mobile running on limited computing power. Main Profile and High Profile are primarily for broadcast applications. High 10 Profile adds 10-bit color subsampling to HiP. Supported levels/resolutions range from 160x112 standard definition video to 1920x1080 high definition video. Typical frame rates range from 5 to 30 FPS. Higher resolutions and frame rates require more computing horsepower to decode. Flash 9 supports hardware acceleration for full-screen playback. The H.264 codec is appropriate for compressing all types of video content.

On2 VP6 was the primary video codec in Flash 8, and it is still supported in Flash Player 9. Supported levels/resolutions are the same as those for H.264 in Flash. VP6 supports both one-pass CBR and two-pass VBR encoding. Use VP6 if your target audience is using computers that aren't capable of handling the H.264 codec either because the CPUs are not up to the task, your audience doesn't have Flash Player 9 or later installed or they are running older operating systems.

1. [http://www.adobe.com/products/player\\_census/flashplayer/](http://www.adobe.com/products/player_census/flashplayer/)

### Flash Audio Codecs

Flash Player supports the AAC Main, AAC-LC and AAC-HE v2 audio codecs defined by MPEG-4 Part 3. As previously mentioned, AAC stands for Advanced Audio Coding; LC indicates Low Complexity and HE indicates High Efficiency. AAC Main is based on the MPEG-2 version of AAC and adds perceptual noise shaping to improve quality at lower bit-rates. AAC Main supports up to 5.1-channel audio. AAC-LC is less efficient than AAC Main, but requires less computing power to encode and decode. AAC-LC is optimized for streaming applications such as Internet radio. HE-AAC v2 enhances frequency domain coding efficiency and improves low bit-rate stereo signals. HE-AAC v2 can handle up to 48 audio channels and 5.1 as well as 7.1 surround sound.

MP3, aka MPEG-1 Layer 3, was the primary audio codec of Flash Player 6. It is optimized for 160kbps data rates at 8kHz.

Speech is a licensed version of the Nelly Moser codec that is best suited for low bit-rate, low-fidelity spoken-word, monaural content.

ADPCM and RAW offer good quality encoding with little or no compression, respectively. Neither is particularly well suited for web delivery.

### QuickTime (Apple Computer, Inc.)

QuickTime was introduced in 1991. It is known for supporting an expansive set of codecs suitable for nearly every media type. In its current incarnation (QuickTime 7), H.264 is its web video codec of choice; AAC-LC is its corresponding audio codec. These are the video and audio compression formats of the popular iPod and the iTunes Music Store.

The QuickTime Player is preinstalled on all Macintosh computers and a version is available for Windows machines. Compatibility between the two versions is essentially at parity. QuickTime Player 7 supports playback of up to full-screen, high-definition content.

QuickTime support for progressive download predates its support of RTSP streaming, which was introduced with QuickTime 4 in 1999. QuickTime streaming requires the Apple QuickTime Streaming Server (QTSS) or the open-source Darwin Streaming Server. QTSS supports streaming live and on-demand content.

### QuickTime Web Codec Support

H.264 is a highly efficient codec designed to produce better quality at substantially lower bit-rates than older codecs such as H.263 and MPEG-1. QuickTime implements H.264 BP (Baseline Profile for low-latency devices such as cell phones) and HiP for high-definition broadcast and Blu-Ray applications. The hard-to-decode features of H.264 (in particular, CABAC entropy coding and multiple reference frames) are turned off in the QuickTime implementation of the codec. This sacrifices some efficiency to achieve faster decoding performance and facilitates instant-on streaming.

H.264 is appropriate for compressing just about any type of video content. One of the codec's strengths is scalability, so you can use it to deliver video at a variety of resolutions and bit-rates to a variety of devices. Lower bit-rate H.264 (~40kbps to 300kbps) can be played on modern cell phones and consumer-level computers. Delivery of H.264-encoded files to other mobile devices such as an iPod Touch can use resolutions of up to 640x480 at data rates of up to 1.5mbps. Higher-definition H.264 files require more computing muscle to decode, so your audience will need to be on sufficiently modern computers and broadband connections to view such content. For an up-to-date list of QuickTime 7 Macintosh and Windows system requirements for H.264 playback at a variety of resolutions and frame rates, see <http://www.apple.com/quicktime/guide/hd/recommendations.html>

Note that QuickTime streaming requires that H.264-encoded files be hinted. Hinting gives the streaming server information it needs to properly stream the media. Prebuilt playlists of AAC-LC-encoded audio files, however, don't require hinting. Rhözet Carbon Coder takes care of hinting automatically during the transcoding process.

MPEG-4 Part 2 is the original MPEG-4 video codec. It has been largely superseded by H.264, which provides up to four times the frame sizes at any given data rate. MPEG-4 video codec support in QuickTime 6 was for the MPEG-4 Part 2 codec. This codec is still supported in QuickTime, but is more useful for video delivery to mobile phones than video on the web.

H.263 is a low bit-rate codec originally designed for teleconferencing. If your audience is using older computers that are not able to decode H.264, H.263 is a viable option. H.263 is limited to native resolutions of 352x288, 176x144 or 128x96. Encoding at other resolutions causes the codec to select the closest supported resolution and scale up on playback. H.264, however, provides much better quality at comparable data rates and is well suited for video conferencing applications. Apple iChat, for example, relies on the H.264 codec.

H.262, aka MPEG-2, has been the codec of choice for standard-definition DVD and broadcast television. It supports interlaced video, a feature that is unnecessary for web-based delivery of video to computer screens. H.262 file sizes are impractical for web delivery of any sort.

MPEG-1 predates the MPEG-2 standard and is still in use today. MPEG-1 video was originally intended for compressing digital video and CD audio down to 1.5mbps at 26:1 and 6:1 compression ratios, respectively, for delivery on VideoCD. MPEG-1 does not support interlaced video, making it a logical choice for web video applications. Two-pass VBR encoding can help mitigate its relative lack of compression efficiency. For a variety of reasons not the least of which is that there are no licensing fees required for implementing MPEG-1 encoding or decoding, MPEG-1 video and audio (including MP3, aka MPEG-1 Layer 3 audio) are among the most widely supported compression formats in the world. If your target audience uses Unix-based computers, progressive download MPEG-1 files offer a viable compression option.

Sorenson Video v3 (SV3) was at one point the default QuickTime video codec. It has been built into QuickTime since v5.02. The SV3 codec works well for progressive download content, and using two-pass VBR can help achieve optimal quality. When streamed with the QTSS, SV3 can dynamically drop B-frames (bidirectional prediction frames used to improve compression efficiency) if there is not enough bandwidth to support a given data rate.

### QuickTime Audio Codecs

AAC-LC, one of the audio codecs in the MPEG-4 suite of standards, is the audio codec of choice for the most recent incarnation of QuickTime (v7.5.5 as of this writing). AAC-LC provides much better compression efficiency than MP3 and includes a native packetizer for RTSP streaming. The codec is appropriate for both speech and music. Complex program material benefits from higher sampling and data rates.

QuickTime 7 supports multichannel audio in MOV files, such as those used in high-definition movie trailers on [Apple.com/trailers/](http://Apple.com/trailers/). The Apple implementation of the MP4 container, however, supports only mono and stereo audio, so multichannel MOV files need to be recompressed when output as MP4 files. Rhözet Carbon Coder enterprise transcoding software handles this transcoding task automatically.

MP3 is still supported in QuickTime. Its implementation does not include a native packetizer, so MP3 is best used for progressive download playback. MP3 provides acceptable quality for both music and speech, and served as the original proof-of-concept for “good enough” compression in the heyday of music file sharing services.

### Windows Media (Microsoft Corporation)

Windows Media Player is included in the Windows OS and is available for Mac OS. It handles streaming and progressive download content, as well as live broadcast and on-demand video. Windows Media offered integrated digital rights management (DRM) features before either QuickTime or Flash. Its DRM technology has been evolving steadily since it was introduced in 1999. All Windows Media Series codecs support the Windows Media Digital Rights Management platform to distribute securely packaged copy-protected digital media.

The Windows Media Player and Silverlight support a limited number of codecs. Principal among them is VC-1 (aka SMPTE 421M), which is a highly efficient codec capable of delivering high-definition, interlaced or progressive-scan video on any medium to any compatible device. Microsoft has announced support for H.264 in an upcoming release of Silverlight. The Windows Media Video (WMV) and Windows Media Audio (WMA) codecs are backward-compatible with earlier versions of the Windows Media Player and compatible technologies.

### Windows Media Video Codecs

Windows Media Video 9 (WMV9) is Microsoft's implementation of the VC-1 codec. It supports Simple, Main and Advanced profiles. Simple and Main support a wide range of bit-rates appropriate for high-definition content and web video delivered at low bit-rate, dial-up connection speeds. WMV9 supports two-pass VBR encoding. Advanced profile VC-1 is transport-independent, meaning it can be used to deliver content to non-Windows Media-based systems including wireless networks using real-time transfer protocol (RTP). Microsoft claims that the Advanced profile achieves comparable quality at data rates as low as one-third that of the MPEG-2 codec. Like H.264, VC-1 can be used to compress all manner of streaming and progressive download video content, from podcasts to high-definition movies on demand. WMV9 is compatible with Windows Media Player 6.4 or later; Advanced profile playback requires Windows Media Player 7 or later.

WMV 9 Image Version 2 is used to turn still images into video using various effects such as pan, zoom and crossfades between clips. Data rates as low as 20kbps can be used to deliver the files. CBR and one-pass VBR encoding is supported. WMV9 Image Version 2 is compatible with Windows Media Player 7 or later. Content encoded with WMV9 Image Version 2 is not compatible with its earlier incarnation, the WMV9 Image codec.

WMV 9 Screen is optimized for compressing sequential screenshots and relatively static video captured from computer displays. The codec leverages the lack of motion to achieve good quality at very high compression ratios. The codec is useful for encoding tutorial and demo videos and delivering content to modestly powered CPUs. WMV9 Screen is compatible with Windows Media Player 7 or later.

### Windows Media Legacy Codecs

Windows Media Video 8 provided competitive quality at a full range of data rates and scaled well, providing good playback on under-powered CPUs as well as the fastest computers of its day. It offered one-pass CBR, two-pass CBR, one-pass VBR and two-pass VBR encoding. Two-pass CBR used an analysis pass to achieve higher average quality at CBR, a mode that was well suited for real-time streaming.

WMV 7 is less efficient than WMV 8, delivering less quality at a given bit-rate. WMV 7, however, is faster to encode than WMV 8. Use this codec to deliver streaming or progressive download video if your audience uses older computers.

### Windows Media Audio Codecs

Windows Media Audio 9 (WMA9) is a codec that is backward-compatible with earlier versions of the Windows Media Player, so it can be used even if your target audience is running Windows Media Player 6.4 or later. The codec uses 16-bit audio and samples at 44.1kHz and 48kHz. Microsoft claims WMA9 can produce CD-quality audio at data rates from 64kbps to 192kbps and yields audio 20 percent better than audio sampled with the Windows Media Audio 8 codec at equivalent data rates. VBR encoding is supported.

Windows Media Audio 10 Professional (WMA 10 Pro) supports a full spectrum of possible resolutions for low bit-rate mobile delivery to full-resolution 24-bit/96kHz stereo, 5.1 and 7.1 surround sound. It is flexible enough to be used to compress audio for playback on computers with high-fidelity audio hardware and for delivering audio on mobile devices. WMA 10 Pro can do streaming, progressive download or download-and-play delivery at 128kbps to 768kbps. Files encoded for multichannel, high-resolution (24-bit/96kHz) playback that are played back on a system that cannot handle multichannel surround sound will playback as 16-bit stereo audio.

Windows Media Audio 9 Lossless is, as its name implies, a lossless codec that creates a bit-for-bit duplicate of the original file, which makes it most useful as an archival format. Content is typically compressed at a 2:1 or 3:1 ratio depending on its complexity.

Windows Media Audio 9 Voice is a low bit-rate codec used for compressing speech. It can also be used to compress content that includes both voice and music. In speech mode, the codec leverages the narrow frequency range and relative simplicity of the human voice to achieve optimal results. In music mode, the codec behaves like the WMA9 codec. Encoded content can be configured to automatically switch between voice and music modes. WMA9 Voice is well suited for streaming Internet radio, podcasts, e-books and voiceovers at bit-rates as low as 4kbps at 8kHz.

MP3 and the Windows Media Audio codecs listed above are supported in Silverlight, and AAC-LC support has been announced.

## LEGACY FORMATS AND CODECS

### RealMedia (RealNetworks, Inc.)

RealNetworks was the first company to offer real-time streaming technology. When RealPlayer was introduced in 1995, it was primarily known as a streaming audio application. Streaming video support was added in 1997. The RealMedia format is often referred to as "RealVideo," even if the content consisted of nothing but audio. RealNetworks SureStream technology required the RealNetworks Helix server and created multiple audio and video streams tailored to accommodate various network conditions including available bandwidth and packet-loss rate. Early versions of the RealVideo codec were based on H.263. RealVideo 8, 9 and 10 used a proprietary video codec developed by RealNetworks. RealVideo 10 (c. 2003) enabled delivery of rich media at any bit-rate on any device.

### RealVideo Codecs

RealVideo 10 (RV10) is 30 percent more efficient than RealVideo 9 (RV9). Real Networks claims RV10 delivers the same quality as H.264 at 15 percent lower bitrates. RV10 is compatible with RealVideo 9 decoders and runs on a variety of operating systems and CPUs, including Windows, Windows CE, Mac OS, Linux and Symbian. RV10 can handle both progressive-scan and interlaced video content. One- and two-pass CBR, VBR and Quality-Based Encoding are supported. The latter maintains a constant level of quality throughout the file being encoded, without regard for bit usage. RV10 supports playback of video on low bit-rate cell phones and mobile devices as well as high bit-rate HD 720p and 1080i resolutions.

RV9 offers significantly better compression efficiency than RealVideo 8 (RV8), although it requires a more powerful CPU to decode. Like RV8, RV9 supports two-pass VBR encoding. Its decoder can play content at frame rates higher than they were encoded at if the CPU exceeds the minimum system requirements. This is accomplished by interpolating motion vectors to generate new frames between existing frames.

### RealAudio Codecs

RealAudio 8 (RA 8 and RA8) is optimized for delivering stereo audio at low bit-rates. A version of Sony's ATRAC-3 (RA 8 — note the space between "A" and "8") codec that is enhanced to allow RSTP streaming can be used for 96kbps and higher data rates. For bit-rates below 96kbps, RealAudio 8 uses a proprietary codec, called RA8 (no space), developed by RealNetworks.

Voice is a speech codec optimized for data rates up to 64kbps.

Music is RealNetworks' audio codec for monaural content, used for 6kbps to 64kbps monaural music clips.

### Miscellaneous

MPEG-1 predates the MPEG-2 standard and is still in use today. MPEG-1 video was originally intended for compressing digital video and CD audio down to 1.5mbps at 26:1 and 6:1 compression ratios, respectively, for delivery on VideoCD. MPEG-1 does not support interlaced video, making it a logical choice for web video applications. Two-pass VBR encoding can help mitigate its relative lack of compression efficiency. All three variants of MPEG-1 (including MP3 audio) are widely supported worldwide. If your target audience uses Unix-based computers, progressive download MPEG-1 files offer a viable compression option.

DivX uses the MPEG-4 Part 2 video codec and is most associated with ripping content to DVDs.

## SUMMARY

Ultimately, choosing an appropriate web video format and codec is a matter of assessing the nature of your content, determining your business goals and evaluating the bandwidth and computing power available to your target audience.

As of this writing, there is no single, silver bullet web video codec solution, although H.264 could soon claim that title. Both QuickTime 7 and Flash Player 9 support H.264, and soon Microsoft Silverlight will too. H.264 is highly efficient and scalable enough to handle delivery across the entire bandwidth spectrum. VC-1 shares those attributes, but its adoption has been limited to Microsoft-centric technologies.

If your audience does not have access to modern CPUs and broadband connections, each of the major formats offers alternative codec choices for just about any type of content in all manner of bandwidth conditions. Regardless of which format(s) and codec(s) best suit your needs, employing highly scalable, universal media transcoding technology such as Rhonet Carbon Coder and Carbon Server gives you the ability to handle high-volume, complex workflows for delivering video and audio content in any web video format at any given resolution and frame rate in a cost-effective manner.

## RESOURCES

Intraframe versus interframe compression	<a href="http://en.wikipedia.org/wiki/Video_compression">http://en.wikipedia.org/wiki/Video_compression</a>
Motion compensation	<a href="http://en.wikipedia.org/wiki/Motion_compensation">http://en.wikipedia.org/wiki/Motion_compensation</a>
FairPlay DRM	<a href="http://en.wikipedia.org/wiki/FairPlay">http://en.wikipedia.org/wiki/FairPlay</a>
Flash DRM	<a href="http://www.adobe.com/products/flashmediarightsmanagement/features/">www.adobe.com/products/flashmediarightsmanagement/features/</a> ; <a href="http://www.adobe.com/devnet/flashmediaserver/articles/digital_media_protection.html">http://www.adobe.com/devnet/flashmediaserver/articles/digital_media_protection.html</a>
Windows Media DRM	<a href="http://www.microsoft.com/windows/windowsmedia/forpros/drm/default">http://www.microsoft.com/windows/windowsmedia/forpros/drm/default</a> <a href="http://en.wikipedia.org/wiki/Windows_Media_DRM">http://en.wikipedia.org/wiki/Windows_Media_DRM</a>
H.264 overview	<a href="http://en.wikipedia.org/wiki/H.264">http://en.wikipedia.org/wiki/H.264</a>
VC-1 overview	<a href="http://www.microsoft.com/windows/windowsmedia/howto/articles/vc1techoverview.aspx">http://www.microsoft.com/windows/windowsmedia/howto/articles/vc1techoverview.aspx</a>
WM and VC-1 in Silverlight 2.0	<a href="http://www.microsoft.com/belux/interactive/newsletter/08-05/articles/mediatechnologies.aspx">www.microsoft.com/belux/interactive/newsletter/08-05/articles/mediatechnologies.aspx</a>

## CODEC TERMINOLOGY

**Codec** — A combination of COmpression and DECompression — words that describe what codecs do. They compress media on input and decompress it on playback. Simply put, a “web codec” is a codec that can be used to deliver media online.

**Container** — A technology that can house many different codecs. Popular web codec containers include Adobe Flash, Apple QuickTime and Microsoft Window Media. These containers are capable of accommodating a wide variety of media types. QuickTime, for example, can handle animation, music, speech, text, video and much more. Containers can also be called “codec containers,” “media containers” or “wrappers.”

**Format** — Comprises one or more containers and a set of codecs.

**Platform** — The device your content will be delivered to and viewed on.

Formats can be either platform-specific or platform-independent. Windows Media Video (WMV) is one such platform-specific format. WMV content is intended for playback on Windows Media Player, Silverlight and compatible applications.

MPEG-1 is an example of a platform-independent format. Flash is a cross-platform, platform-specific format. That is, Flash Player is compatible with a variety of operating systems, but Flash content is intended for playback on the Flash family of players, which includes Flash Player, Flash Lite for mobile playback and Adobe Media Player.

**Note:** If you would like to learn about more of the technical jargon associated with media compression, the “Transcoding 101” white paper can help you quickly get up to speed. Find it at: ([http://www.rhozet.com/transcoding\\_101.pdf](http://www.rhozet.com/transcoding_101.pdf))