The future is fusion

AMD Video Technologies

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INTRODUCTION

High Definition (HD) content is gaining in popularity among consumers looking for an immersive entertainment experience, thanks to the availability and affordability of HD capable TVs and displays, in combination with a faster pace of releases of movie titles on both HD DVD and Blu-ray discs.

Given that the personal computer (PC) has been the vehicle of choice for delivery of different types of digital content, PC manufacturers started delivering to the market components for HD playback, such as new optical drives. However, upgrading current PCs with new Blu-ray and/or HD DVD optical drives does not guarantee that the rest of the PC components will have sufficient processing capability for fully featured and acceptable HD content playback, such as large quantities of data processing (up to 6 times the rendering required for SD), computational complexity of algorithms for decode (e.g. CABAC), post processing and power consumption in software (CPU) or GPU assisted decoding scenarios.

This paper looks at the challenges of HD playback on the PC and the dedicated set of technologies implemented by AMD on graphics processing units (GPUs) that provide efficient and high quality HD playback.

SEAMLESS & EFFICIENT HD PLAYBACK

Unified Video Decoder (UVD)

To enable full HD video decode on a complete range of PC graphics solutions, AMD introduced the Unified Video Decoder (UVD) with AMD Radeon™ HD 2600 and HD 2400 family of products. UVD is a dedicated video decoding block that facilitates the full, bit accurate, decoding of VC-1 or H.264/AVC encoded video. Figure 1 illustrates a functional diagram of the decoding stages of a 1st generation UVD.

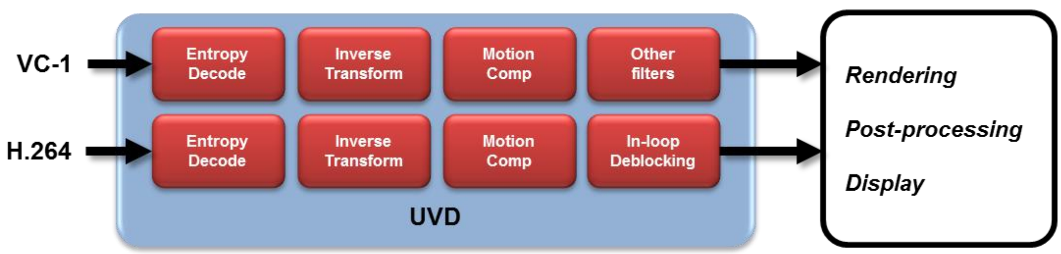
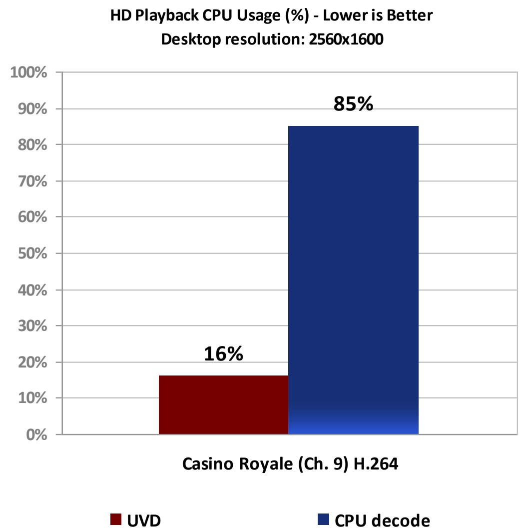


Figure 1: 1st generation Unified Video Decoder

By utilizing dedicated hardware for the decoding of VC-1 and H.264 with UVD, the central processing unit (CPU) is completely decoupled from the video decoding process, including the CPU intensive entropy decoding stage. The net result of removing the entire decoding process off of the CPU to the GPU is that significant CPU cycles are freed up.



System: AMD Athlon 64 X2 6400+ 3.2 GHz 2GB RAM Windows Vista® Ultimate

Figure 2: Example of CPU utilization during H.264 playback

In Figure 2, CPU utilization is measured during playback of chapter 9 of the movie Casino Royale[1], encoded in H.264 at 1080p. UVD decoding sends the CPU utilization to very low levels. In this case there is only 16% utilization – equating to a removal of approximately 70% of the CPU cycles that would have been spent decoding the video under the CPU decode case. The remaining 16% CPU utilization is the operating system (OS) and application overhead required when playing back from an HD optical source. With UVD, VC-1 decoding also benefits from the same low CPU utilization.

One benefit of switching processing from a CPU based software decoding to a dedicated processing solution on the GPU is lower overall system power utilization. This decrease in power utilization is beneficial in a notebook PCs because HD playback processing places a greater burden on the battery. For desktop computers used as Home Theater PCs (HTPCs) this means lower CPU fans rotations, and a quieter environment during video playback.

3rd generation UVD

With the AMD Radeon™ HD 6800 family of GPUs, a new generation of UVD is introduced to enable acceleration of wider range of video formats and media, both from file based and optical sources.

This 3rd generation, named UVD3, provides acceleration for MPEG-2 bitstream, MPEG-4 part 2 ASP (also known as DivX/xVid) and Multi-View Codec (MVC) formats. Figure 3 illustrates the evolution of UVD architecture since its introduction until its 3rd generation.

One key addition to UVD3 is MVC decode. This format is the only codec used in Blu-ray 3D movies specifications. MVC combines two stereo views encoded in H.264, adding tremendous processing requirements. With UVD3, AMD brings Blu-ray 3D playback to mainstream PCs, by offloading decode to AMD Radeon™ HD graphics[2]. Figure 4 shows an example of Blu-ray 3D decode and the benefits of offloading MVC decode from the CPU.

[1] *Casino Royale* © 2006 Metro-Goldwyn-Mayer Inc.
[2] Blu-ray 3D support may vary per product. For details, refer to the specific product page online at www.amd.com

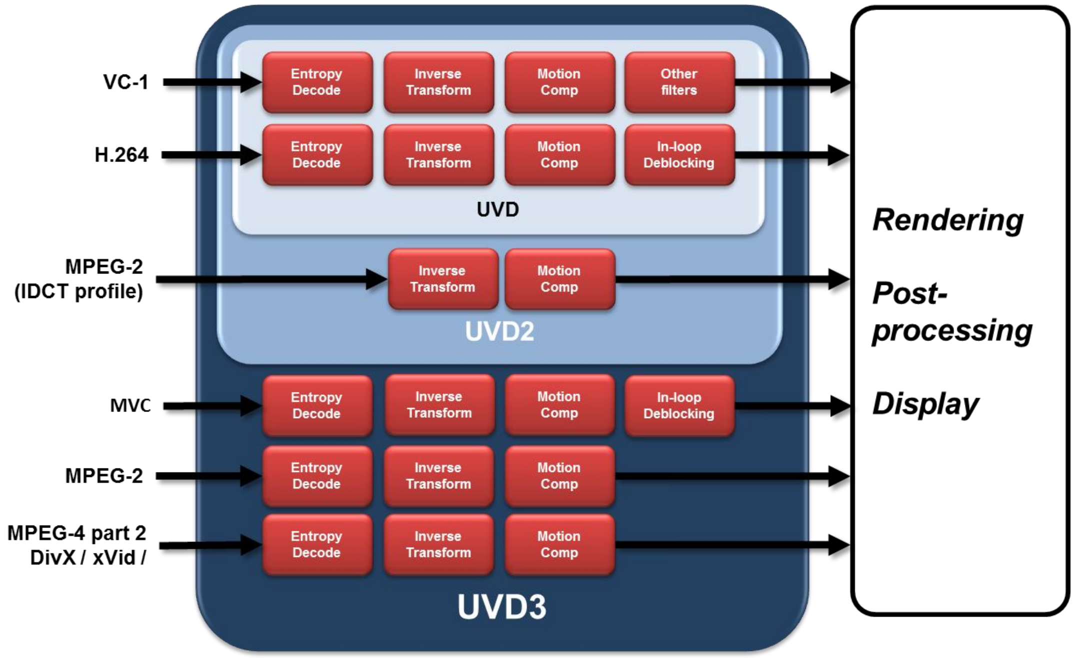


Figure 3: AMD's Unified Video Decoder Evolution

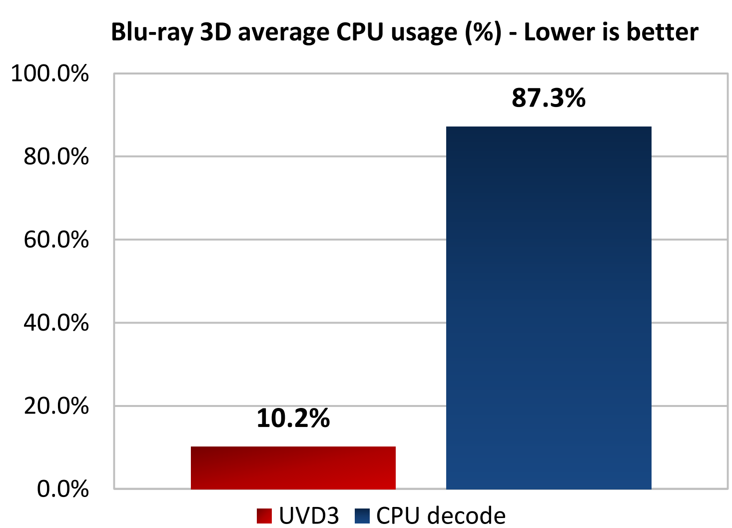


Figure 4: Example of CPU utilization during Blu-ray 3D[3] playback
System: Athlon II X2 215 2.7GHz / 4GB RAM / Windows® 7 Ultimate / AMD Radeon™ HD 6870 1GB GDDR5
Software: AMD drivers 8.78_RC2 / CyberLink PowerDVD 9 (9.0.3216.52)

[3] *Cloudy with a Chance of Meatballs* 3D © 2010 Sony Pictures

CLEAR & CRISP IMAGE QUALITY

AMD's HD post processing

The video frames decoded from a video stream can go through post processing to improve the image quality and correct visual artifacts from the source video introduced during production or distribution of the content (e.g.: broadcasting or internet streaming). Main causes for these visual artifacts are video interlacing, resolution reduction and high compression and scaling.

Each user can have a preference for a different set of visual controls, such as colors or sharpness. AMD's post processing features different video quality enhancements and user controlled settings to provide a superior visual experience during playback, independently from the type (HD or SD) of the video source.

Below is a discussion of the main video quality processing featured in AMD Radeon™ HD graphics:

Advanced De-interlacing and Inverse Telecine

HD content on optical discs is usually encoded as series of full progressive frames, mainly in 1080p resolution. However, interlaced video remains dominant today as most broadcast video (SD and HD) and video on standard DVD discs are interlaced. Playback of interlaced video on progressive displays requires the conversion of the content from interlaced – two fields representing half the vertical resolution each - to a full vertical resolution progressive frame. This process is called de-interlacing.

Figure 5: De-interlacing algorithms

There are different algorithms to de-interlace video. The most basic ones are replication of lines of a field ("weave") and averaging of lines of a field ("bob"). AMD Radeon™ HD includes advanced de-interlacing algorithms that take into account the temporal element of the video improving dramatically the visual quality of the picture (Figure 5).

Inverse telecine, also known as "pulldown detection", is another sophisticated post-processing used for a seamless and smooth playback of movie titles encoded in interlaced format. This processing is used to obtain the best image quality with titles created originally on film at 24 frames per second (fps) progressive, but encoded as interlaced video at 30 fps on optical discs, such as DVDs. At encode time, 6 intermediate frames are duplicated to achieve 30fps from 24fps. This group of frames is called pulldown sequence. There are several types of pulldown sequences. The most common for film is 3:2 pulldown.

Playback of such interlaced video on progressive monitors require the detection of the type of pulldown sequence to remove it and playback only the original frames in order to deliver a seamless playback with best visual quality. This is achieved by inverse telecine post processing, another advance post-processing featured in AMD Radeon™ HD.

Display Resolutions beyond 1080p

High resolution displays for PCs, such as dual-link monitors, are becoming more available and affordable. These monitors support resolutions higher than 1080p, up to 2560 x 1600. This represents a challenge for playback of HD as well as SD videos because scaling up the video to the display resolution will have an amplifying effect on any artifacts existing in the source video, and will likely introduce aliasing artifacts on the picture. The display engine in AMD Radeon™ HD enables high quality scaling of video to resolutions higher than 1080p with for an immersive entertainment experience[4].

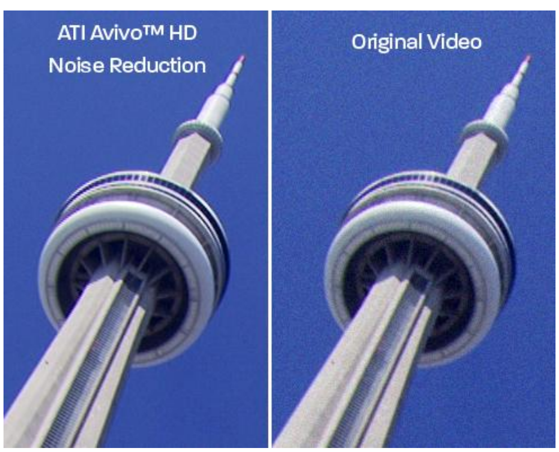
Color Vibrancy and Adjustments

The AMD Radeon™ HD display engine processes data at 10-bits per color (30-bits total) enabling over 1 billion colors on 10-bit capable displays.

For video playback, AMD Radeon™ HD exposes advanced color controls, allowing users to adjust colors saturation and vibrancy for vivid colors in the video, while preserving the natural look of human skin through an advanced “fleshtone” post-processing during video playback. Figure 6 illustrates the result of color vibrancy adjustment on a video with AMD’s HD post-processing.

Simulated images

Figure 6: Color vibrancy adjustments



Simulated images

Figure 7: Noise reduction example

Noise Reduction and Edge Enhancement

Noise reduction is a post processing operation performed on video to remove noise artifacts introduced by the camera during the shooting or during transfer or compression of the video.

Noise reduction introduces specific challenges: detecting true noise pixels from valid ones, preserving details in the picture, and avoiding common “ghosting” artifacts in sophisticated algorithms like Temporal Noise Reduction (TNR).

AMD’s approach to noise reduction is both advanced, using TNR to lower risk of removing valid pixels, and balanced in the strength of noise reduction to eliminate “ghosting” artifacts while preserving details of the picture. Figure 7 illustrates the original video with noise in the source, which is easily noticeable in the blue sky, and the video with AMD’s HD noise reduction, which preserves details on the tower.

[4] Supported resolutions may vary per product. For details on supported resolutions refer to the specific product page online at www.amd.com

ACCELERATED VIDEO TRANSCODING

With the increasing number of media sources and playback devices, users are constantly looking for a fast and seamless way to move and manage video content.

In 2009, AMD introduced the Accelerated Video Transcoding (AVT) architecture to help speed up video conversation. AVT is a combination of hardware and low level software to convert H.264 and MPEG-2 video sources, up to 1080p resolution, to H.264 MPEG-2 file format to fit the target device supported resolutions and bitrates, up to 1080p resolution, as illustrated in Figure 8.

Figure 8: AMD's Accelerated Video Transcoding architecture

AVT leverages all resources in the system, including UVD and compute processors to accelerate the overall process, while keeping CPU usage and low levels for a balanced and responsive PC as illustrated in Figure 9.

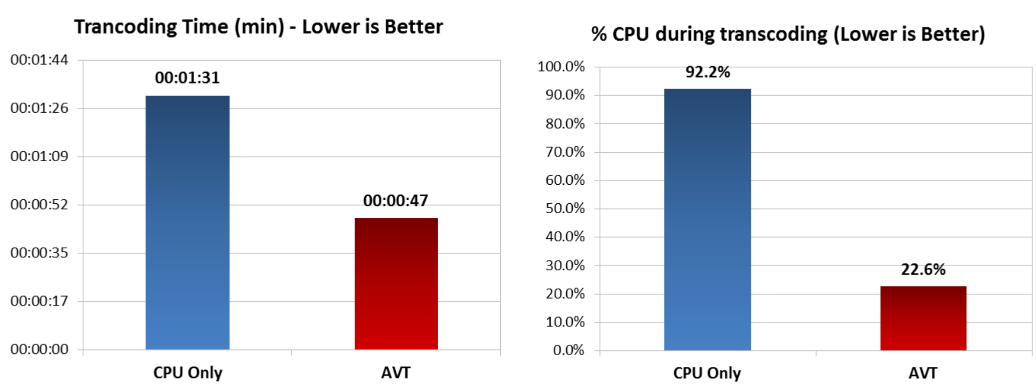


Figure 9: AVT transcoding speed and CPU usage

System: Athlon II X2 215 2.7GHz / 4GB RAM / Windows® 7 Ultimate / AMD Radeon™ HD 6870 1GB GDDR5
Software: AMD drivers 8.78_RC2 / CyberLink MediaEspresso 6 (6.0.0722_28792)
Transcoding: 1080p H.264 video @20Mbps to iPhone target 640x480 video

SUMMARY

The challenges of video playback go beyond the simple decode to include video quality challenges, especially on high resolution displays, and acceleration of content management operations, such as transcoding.

AMD delivers a comprehensive set of video and display technologies designed to enable a seamless video playback and use power efficiently with high visual quality on AMD Radeon™ HD graphics, to truly provide users with The Ultimate Visual Experience™.

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