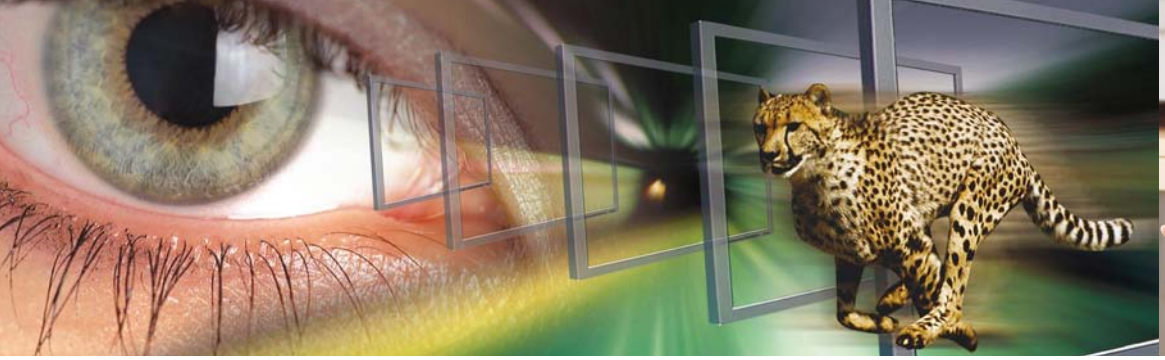


Introduction to H.264

What is H.264?

H.264 is a new video compression scheme that is becoming the worldwide digital video standard for consumer electronics and personal computers.

In particular, H.264 has already been selected as a key compression scheme (codec) for the next generation of optical disc formats, HD-DVD and Blu-ray disc (sometimes referred to as BD or BD-ROM)

H.264 has been adopted by the Motion Picture Experts Group (MPEG) to be a key video compression scheme in the MPEG-4 format for digital media exchange. H.264 is sometimes referred to as "MPEG-4 Part 10" (part of the MPEG-4 specification), or as "AVC" (MPEG-4's Advanced Video Coding).

This new compression scheme has been developed in response to technical factors and the needs of an evolving market:

- MPEG-2 and other older video codecs are relatively inefficient.
- Much greater computational resources are available today.
- High Definition video is becoming pervasive, and there is a strong need to store and transmit more efficiently the higher quantity of data of HD (about 6 times more than Standard Definition video).

Why H.264 is The Next Big Thing

Quality and Size (Bit-rate)

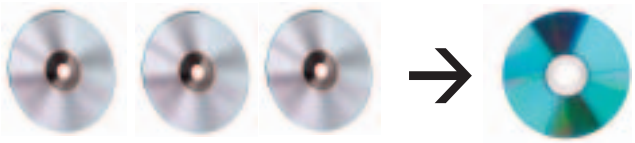
H.264 clearly has a bright future, mostly because it offers much better compression efficiency than previous compression schemes.

The improved efficiency translates into three main benefits, or a combination of them:

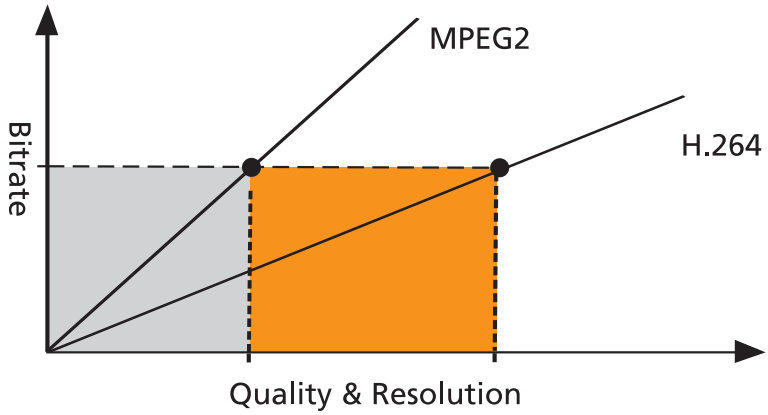
- **Higher video quality at a given bit-rate:** reduction in artifacts such as blockiness, color bands etc.

- **Higher resolution:** as the video world transitions to High Definition, a mechanism is needed to deliver it.

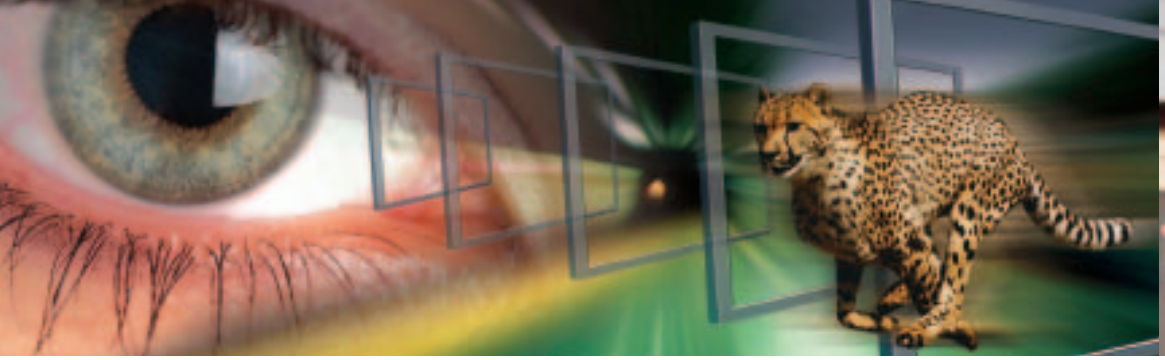
- **Lower storage requirements:** lower storage requirements will allow for large amounts of content to be delivered on a single disc.



While a more detailed comparison of MPEG-2 to H.264 is given below, a high-level comparison is illustrated by this graph.



Here we see that for a given bit-rate, the level of video quality or resolution (both of these contribute to greater bit-rate) for H.264 can be higher than for MPEG-2.



Next Generation Digital TV

It is likely that future delivery of Digital TV signals (both in SD and HD) will use H.264. For SD, the same content at a given quality can be delivered with a lower bit-rate (allowing for more channels to be transmitted on the same medium), or higher quality and/or higher resolution can be delivered at the same bit-rate.

Future Digital TV delivery vehicles include:

- Satellite
- Cable
- IPTV (over cable or DSL)
- Over-the-Air broadcast

Some of the above are already turning to H.264 as a standard; worldwide, more are likely to announce that they are following shortly.

High-Definition Optical Discs

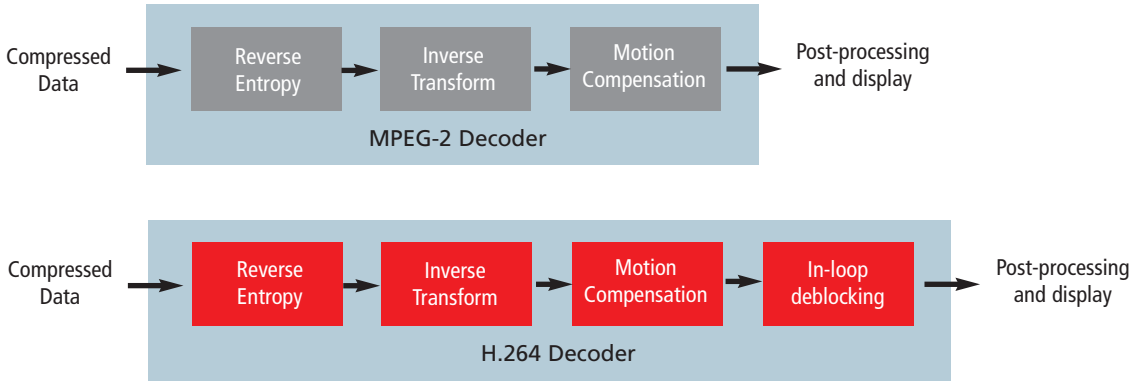
High-definition video is gaining in popularity, aided by the falling cost of HD television sets. A key deployment vehicle for High Definition content is likely to be optical discs carrying this content. Two optical disc formats are currently proposed: Blu-ray Disc, and HD-DVD. While these formats differ in several ways, both have chosen to adopt H.264 as one of the key means of storing the HD video content.

The high bit-rates that are used to encode the video on these HD-discs will be particularly challenging today's PCs; we will examine this further after we compare MPEG-2 and H.264)

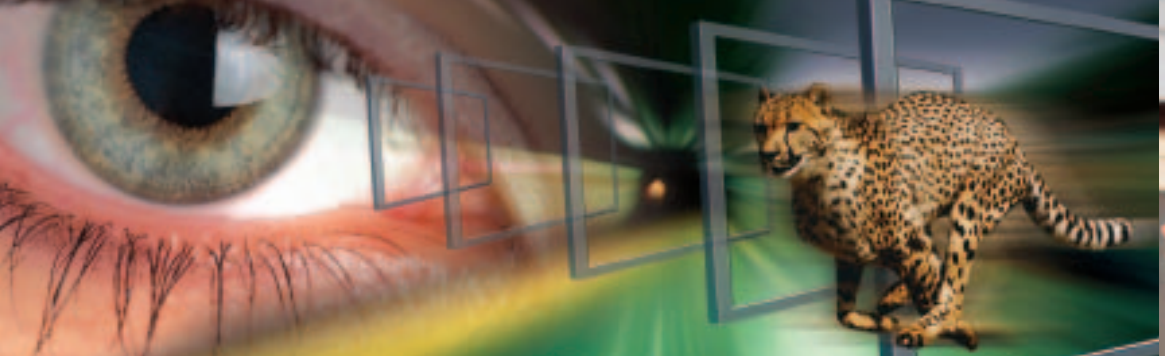
Comparison to MPEG-2

MPEG-2 is today's dominant video compression scheme; it is used to encode video on DVDs, to stream internet video and is the basis for most worldwide digital television (over-the air, cable and satellite)

While MPEG-2 is a video-only format, MPEG-4 is a more generic media exchange format, with H.264 as one of several video compression schemes offered by MPEG-4.



Differences between H.264 and MPEG-2 video decoding



There are numerous differences between these compression schemes, but a key point is that H.264 has been developed to deliver much higher compression ratios than MPEG-2. However, this greater degree of compression (up to 2-3 times more efficient than MPEG-2) comes at the expense of much higher computational requirements. This additional computational complexity is widespread in the overall decoding process, but three key techniquesareas stand out in adding to the new overhead: Entropy encoding, smaller block size and In-loop deblocking.

Entropy encoding:

Entropy encoding is a technique used to store large amounts of data by examining the frequency of patterns within it and encoding this in another, smaller, form.

H.264 allows for a variety of entropy encoding schemes, compared to the fixed scheme employed by MPEG-2. In particular, the new CABAC (Context-based Adaptive Binary Arithmetic Coding) scheme adds 5-20% of compression efficiency but is much more computationally demanding than MPEG-2's entropy encoding.

Smaller block size:

MPEG-2, H.264, and other most other codecs treat portions of the video image in blocks, often processed in isolation from each another. Independently of the number of video pixels in the image, the number of blocks has an effect of the computational requirements.

While MPEG-2 has a fixed block size of 16 pixels on a side (referred as 16x16), H.264 permits the simultaneous mixing of different block sizes (down to 4x4 pixels). This permits the codec to accurately define fine detail (with more, smaller blocks) while not having to 'waste' small blocks on coarse detail.

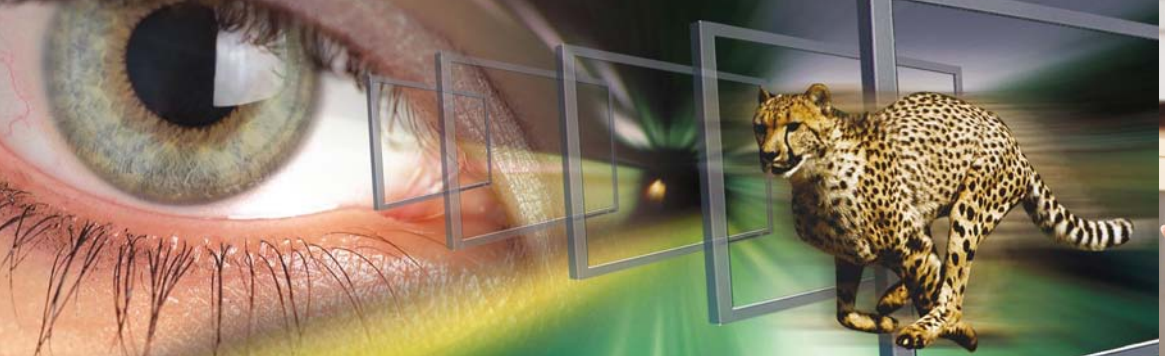
In this way, for example, patches of blue sky in a video image can use large blocks, while the finer details of a forest in the frame could be encoded with smaller blocks.

In-loop deblocking:

When the bit-rate of an MPEG-2 stream is low, the blocks (and specifically, the boundaries between them) can be very visible and can clearly detract from the visual quality of the video. "De-blocking" is a post-processing step that adaptively smoothes the edges between adjacent blocks.

De-blocking is computationally "expensive". In the past, de-blocking has been an optional step in decoding, only enabled when it was possible for the playback device (such as a PC) to perform it in real time. ATI has offered de-blocking capability for playback of video for some time.

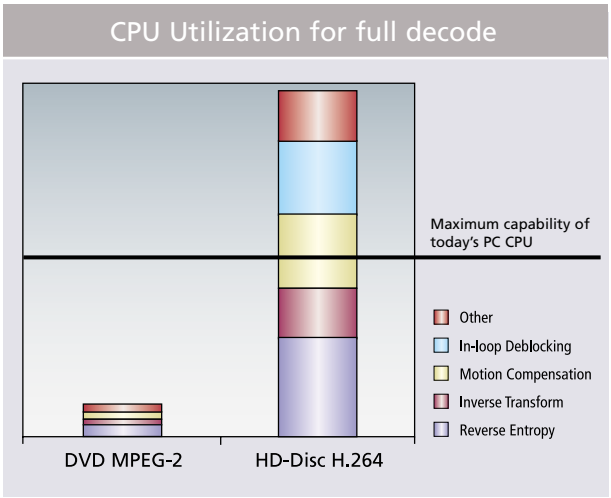
In H.264, however, *In-loop deblocking* is introduced. The "in-loop" refers to when previously 'deblocked' image data, in addition to being displayed, is actually used as part of the decoding of future frames; it is in the decoding 'loop'. Because of this, the de-blocking is no longer optional. It adds to the quality of the decoded video, but also adds significantly to the computational overhead of H.264 decode.



Computational Overhead – The Problem

As we have seen, particularly in comparison to MPEG-2, H.264 delivers the means for the next wave of video to move efficiently to High Definition, but at a very high computational cost.

Below is a comparative view of the computational requirements of MPEG-2 and H.264 broken down by the steps involved. The processing requirements are in terms of a high-end PC CPU available today. The bar drawn in the image shows the point at which the CPU is 100% loaded.



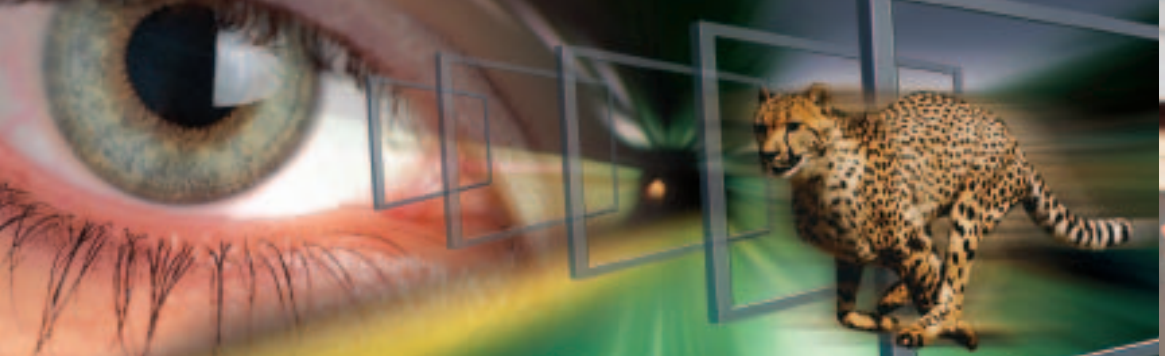
The fact that processing is required above and beyond what a PC CPU can provide today has disconcerting ramifications for playback of High Definition discs on the PC – unless a means can be found to offload (accelerate) some of the tasks to another part of the system.

ATI LEADS AGAIN

ATI's hardware-assisted H.264 decoding process consists of offloading some of the work from the PC's CPU to ATI's VPU (Visual Processing Unit). Without ATI's hardware-assisted decoding, the complexity of H.264 decoding makes it impossible to rely solely on the PC's CPU.

ATI will enable Blu-ray Disc and HD-DVD playback on the PC by having the VPU perform the In-loop deblocking, motion compensation, and inverse transform portions of H.264 decoding.

ATI is already demonstrating the ability to accelerate the H.264 decoding process with its highly flexible VPUs. ATI is well poised to lead another PC video revolution, assisted by expertise in video decode and video processing, and the video processing flexibility built into every single next-generation Radeon®-based product.



GLOSSARY

Bit-rate:
The amount of compressed video data delivered into the decoding system. The higher the bit-rate, the higher the quality and/or the resolution of the video. For optical disc formats, this is usually measured in megabits per second (Mbps).

Codec:
Contraction of COmpressor-DECompressor. This term is often used to refer to the compression scheme used for video processing.

Compression:
The process of shrinking the size of data so that it uses less storage space and less transmission bandwidth. With video, sacrifices in video quality are almost always "traded off" against the resulting file size.

Compression efficiency:
This is loosely defined as being the amount of compression achieved on a given video image or sequence while maintaining a given image quality as compared with a different compression scheme.

High Definition, Standard Definition (HD, SD):
Refers to the resolution or number of pixels used to represent a single video image frame. Standard Definition refers to having about 350,000 pixels per frame, and High Definition refers to having about 2,000,000 pixels per frame, (or about 6 times more than SD).