OVERVIEW of FULLSTREAM™

Internet users have access to more video and multimedia content than ever before. However, when these media-rich files are transferred without the proper bandwidth, the audio and video quality suffers. The user is left with an unsatisfying experience, and online technologies are not explored to their potential. FULLSTREAM™, the latest industry-leading innovation by ATI, helps remove the problems limited bandwidth causes.

Without sufficient bandwidth, Internet video is affected by pixelation and large blocky artifacts during playback. FULLSTREAM™ intelligently detects the edges of these visible blocks and smoothes them over using a sophisticated filtering technique. FULLSTREAM™ delivers smoother-looking, higher quality video content and offers a more immersive experience - without putting extra demands on the CPU.

Bandwidth issues of the Internet

Dial-up remains the most common type of connection to the Internet by a wide margin. With a dial-up connection, the amount of bandwidth available is limited to 56,000 bits per second. Broadband connections, such as ADSL and cable modems, will provide bandwidth of around 300,000 bits per second. While many users would like to access streaming video online, the majority of dial-up connections provide insufficient bandwidth to properly stream content. To transmit quality video on the Internet, over 700,000 bits/second of persistent bandwidth is the minimum requirement.

This type of bandwidth may be delayed in becoming an industry standard. Telecommunication carriers have slashed their capital budgets and delays have been caused in the purchase of new equipment. As a result, the bandwidth problem for video on the Internet is expected to persist in the near future. This knowledge opened the door to explore alternate solutions to additional bandwidth, such as FULLSTREAM™.

## Symptoms of limited bandwidth on Internet video

When insufficient bandwidth is used to transmit video data, the usual symptoms are blocky artifacts and pixelation effects during playback. The cause of these quality degradations lies in the nature of how video is encoded in block-based codecs. In traditional block-based video codecs such as MPEG-1, MPEG-2, MPEG-4 and H.261, each frame is divided into many uniform sized blocks for compression. The common size of a block is an 8 by 8 pixel square. The general encoding algorithm will exploit both temporal and spatial compression, which can both affect video quality in different ways.

Temporal compression, usually known as motion estimation, utilizes an intelligent searching algorithm to look for the best matching block from some reference frames previously decoded. The discrepancies between the current block and the best matching one are then spatially compressed by using discrete cosine transform (DCT). Up to this point, all the compressions applied are lossless as the original data can be faithfully reconstructed. Due to insufficient bandwidth, not all the DCT data can be encoded into the video stream. The DCT data is then further compressed by quantization (division and truncation) to reduce the number of bits for encoding in order to fit into the available bandwidth. The smaller the bandwidth available, the greater the precision loss in this quantization process. This precision loss will weaken the inter-block correlation and create discontinuities between adjacent blocks. This will result in blocky artifacts and pixelation effects that we usually encounter on Internet video.

The FULLSTREAM™ solution

The latest industry innovation from ATI, FULLSTREAM™ is a pixel shader based video processing technology that improves the quality and performance of video playback. The processing mechanism of FULLSTREAM™ can be divided into two major components: Image Analysis and Pixel Optimization. After a video frame has been decoded, the Image Analysis module will study the composition of the frame and determine where are the areas of quantization discontinuity for Pixel Optimization. Algorithms with artificial intelligence in Image Analysis are used to locate blocky areas, which will then be passed to Pixel Optimization.

Once such discontinuity has been identified in FULLSTREAM™, Pixel Optimization will examine the RGB values of those pixels across the boundary of the blocks. Based on the profile of those RGB values, an adaptive multi-tap filter will be applied to those pixels, and their RGB values will be changed accordingly. Pixel Optimization will re-establish the inter-block correlation and reduce the discontinuity across the boundary. The resulting video will be far smoother and appear much more natural to the human eyes. Overall, FULLSTREAM™ will improve both the performance and visual quality of Internet video playback.
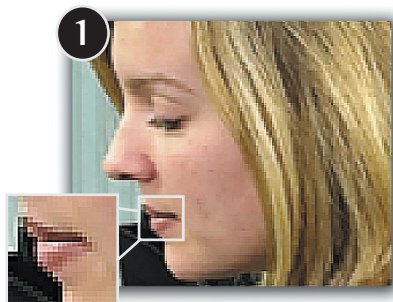
Original video frame with blocky artifacts
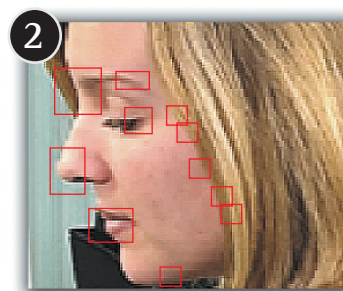
Image Analysis: Locate quantization discontinuity
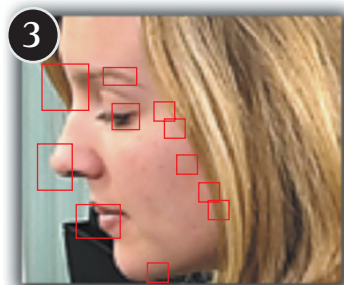
Pixel Optimization:Recreate inter-block correlation

Improved video frame from FULLSTREAM™

• Benefits of FULLSTREAM™

Exceptional Video Performance

- FULLSTREAM™ provides better performance than traditional solutions as it is accelerated by optimized hardware

- Using graphics hardware to handle Image Analysis and Pixel Optimization reduces the load on the CPU in video playback

- Parallel pipeline architecture of graphics hardware enables multi-stream video processing

- FULLSTREAM™ is powered by its own dedicated resources and is not affected by other system interruptions (e.g. mouse scrolling, other CPU work like processing of incoming e-mails, etc.)

Exceptional development flexibility

- FULLSTREAM™ allows singular focus on core programming logic as video processing limits are virtually eliminated

- FULLSTREAM™ unleashes the creativity of developers by removing the constraints in video processing performance

- FULLSTREAM™ expands the limits on resolution and quality of video in a bandwidth limited environment