



Technical Brief

Delivering Superior Visual Quality
Video Enhancements for
Microsoft Windows XP
Media Center Edition 2004

Microsoft Windows Media Center Edition: The Optimized NVIDIA Implementation

With the introduction of Microsoft® Windows® XP Media Center Edition (MCE) 2004, Microsoft leads the latest movement to take the PC into the family room and thereby opening new markets for PCs and PC applications. Featuring a new standard user interface to access and view entertainment media, consumers gain a new range of PC-based products for television viewing, listening to music, playing videos and DVDs, and other related activities.

NVIDIA® has a long history of multimedia innovations, which put it in the right position to offer an implementation of different APIs (application program interface) designed to enhance the quality of the video playback with Microsoft MCE 2004. These NVIDIA enhancements allow users to get the most out of their PC-based entertainment activities, and additionally provide improved image quality, optimized performance, and automatic adjustments of the output for a PC display or television, whichever is specified by the user.

This document provides an overview of the features and functions of the NVIDIA MCE 2004 enhancements.

Media Center PCs

Microsoft offers new APIs for building Media Center PCs¹ with integrated capabilities for a full range of digital entertainment experiences. The Media Center PC can take its place at the heart of the home, providing a platform for managing and using the following applications:

- ❑ Traditional PC productivity applications
- ❑ 3D Gaming
- ❑ Videos and DVDs
Search through and play back stored videos using thumbnail icons for quick identification. DVDs can be played using an integrated PC DVD drive with built-in support for multiple DVD formats and decoding.
- ❑ Digital pictures
View single pictures and create multi-picture slide shows with your choice of music in the background.

¹ Expanded PCs with all of the traditional computing and networking capabilities, plus the functionality required to make them total solutions for digital media playback.

- ❑ Music
Media Center PCs act as digital jukeboxes, storing and retrieving music, allowing intelligent searches, and storing and displaying CD covers.
- ❑ Live television broadcasts or stored programs.
MCE systems let users pause, rewind, and fast forward live TV, similar to other personal video recorder (PVR) products available today, but using the standard MCE interface. The record buffer stores approximately 25 minutes for live TV viewing functions. Users can also schedule recordings of entire shows using an electronic programming guide (EPG) menu with search-by-keyword capability.
- ❑ Remote control for all of the digital entertainment functions (wireless remote capabilities)

As the range of Media Center PC offerings increase, consumers will be able to replace their DVD players, CD players, and VCRs with Media Center-enabled PCs.

The Microsoft Media Center Edition (MCE) also includes a standardized interface that has a desktop icon to launch a Media Center window or run the Media Center as a full-screen application. Significantly larger text makes it possible to view the Media Center window from across the room, unlike a standard desktop window. The Media Center interface serves to integrate the access of all digital media content that has been catalogued by the Windows Media Player on the PC. The remote control offers a single control device for all media functions, and a single menu simplifies navigating through the online digital environment.

The NVIDIA Implementation

NVIDIA has implemented several key enhancements to the Microsoft Media Center Edition.

- ❑ NVIDIA enhancements to the graphics driver include the following:
 - Full dynamic-range color conversion
 - Combining de-interlacing and sub-stream compositing operations for optimized colorspace conversion
 - Automated video encoder control for handling the differences between televisions and PC displays
- ❑ NVIDIA enhancements to the MPEG-2 decoder driver include the following:
 - Video Mixing Renderer 9
 - ProcAmp controls
 - Support for remote control operation

These enhancements are discussed in the following sections, using the terms defined below:

❑ **Video stream**

The principle image data comprising a displayed video frame. Pixels from the video stream area are always opaque and do not contain any per-pixel alpha data

❑ **Video substream**

A channel of auxiliary image data that must be combined with a sample from the video stream prior to display of the combined video frame. Examples of video substream applications are closed-caption images, DVD sub-picture images, and PAL Teletext images. Video substreams contain limited color range and per-pixel alpha information.

❑ **Video Mixer Renderer (VMR)**

The default video renderer on Microsoft Windows XP and later operating systems. This DirectShow-based component uses the capability of the graphics subsystem to display video, and also exposes Direct3D, DXVA, and other APIs to the application. Microsoft MCE uses VMR.

Graphic Driver Enhancements

A Full Range of Color

Color spaces often use color values ranging from 0 to 255 for a total of 256 discrete colors. When converting between video, which uses a *YUV* color format, and standard computer monitors, which use *RGB* color formats, the colorspace is sometimes clamped. A range of color is lost with clamping, leaving only values of 16 to 235. This conversion scheme results in the loss of blacks and whites at the lower and upper ends of the range. It becomes difficult to distinguish between different shades of blacks and whites. Black-on-black details are lost; similarly white-on-white colors are “crushed” with the limited range of colors.

The NVIDIA colorspace conversion solution delivers a full range of color, avoiding the crushed blacks and whites of alternative color conversion schemes. The increasing color range includes seventeen different ranges of black and twenty ranges of white. The original color fidelity of the video information is preserved after conversion, improving the richness of the user experience with superior dark and bright scenes.

Optimized Colorspace Conversion

The process of converting video data for output to a computer display involves five main steps (see Figure 1). As in any mathematical process involving multiple steps, the levels of precision are reduced in each stage of the conversion. To preserve the original levels of detail in the video data, NVIDIA has implemented a VMR extension called **DeinterlaceBitEx** that moves the color conversion step to the end of the process. By keeping the video and sub-stream data in native *YUV* (video) format for as much of the process as possible, the NVIDIA implementation minimizes any loss of color precision.

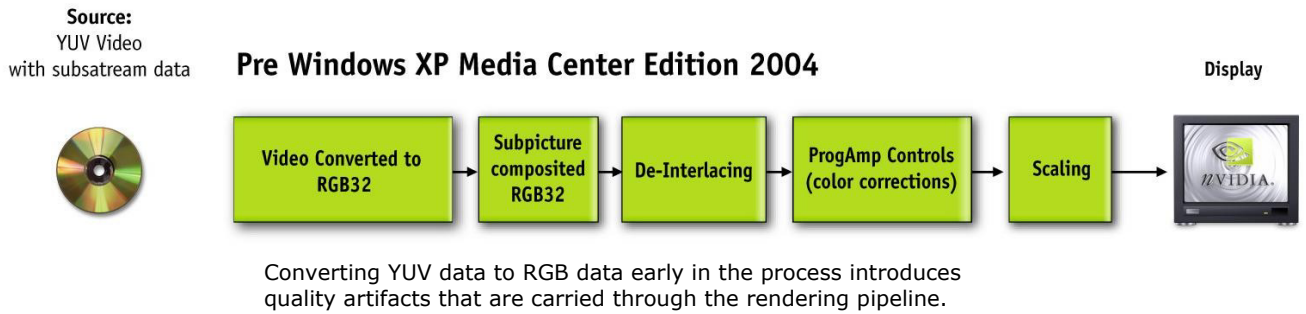


Figure 1. Five Steps to Convert Video for Output to a CRT

The NVIDIA implementation also combines two steps in the overall conversion process (see Figure 2). By using a single call for the de-interlacing and sub-stream compositing operations, the graphics driver can perform the two operations in the most efficient manner based on the hardware resources. For end users, delaying color conversion and combining the de-interlacing and sub-stream conversion operations result in:

- ❑ **Performance improvements**

By combining the operations in a single call, multiple passes are avoided and a minimized time-to-result is achieved.
- ❑ **Enhanced visual quality**

Manipulating the video streams in native YUV format retains the original image precision. Converting to RGB color format at the last possible stage carries the data forward in a protected, or un-degraded, state.
- ❑ **Reduced memory usage**

The NVIDIA conversion process minimizes the amount of required video memory, enabling a solution that performs optimally on the broadest range of graphics processing units (GPUs). Instead of converting all video and substreams into 32 bits per pixel (bpp), video is left in 12 bpp and substreams are defined in 8 bpp.

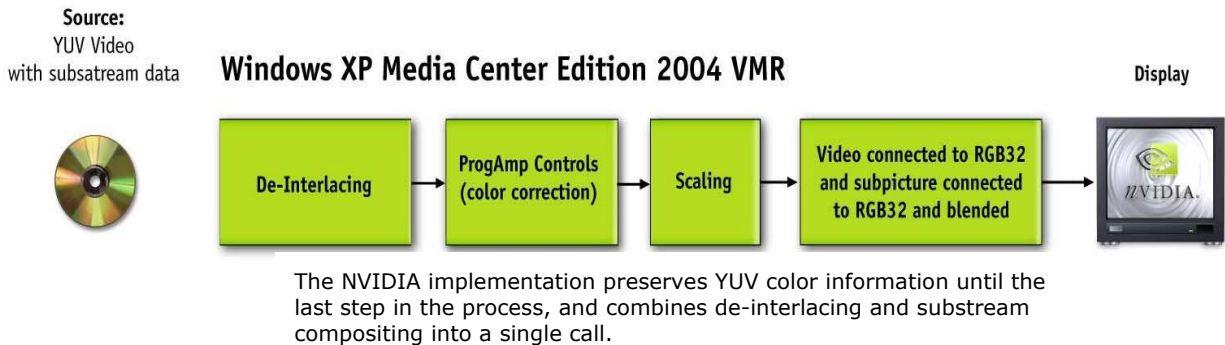


Figure 2. Combining De-interlacing and Substream Compositing into a Single Call

Adjusting for TV and PC Screen Differences

Television screens and computer displays differ in many ways. Television has been optimized for moving pictures, while computer displays have been tuned for graphics and text. To combine the two worlds—television and computers—the Microsoft MCE platform allows viewers to watch television images on their computer displays, or use a computer to drive output to a television. The NVIDIA enhancements to MCE include features that optimize the output for both cases. Accomplishing this task involves the use of two video output features:

- **Flicker filter**

When driving output to a television display, flickering is likely to occur. The flickering effect comes about because of the differences between computer displays and televisions regarding de-interlacing techniques and refresh rates. To reduce flickering, the Microsoft API includes a flicker filter. The filter, when enabled, averages the adjacent lines. A slight loss of resolution occurs, so the amount of flicker filtering is software controlled so it can be optimized for each image being displayed.

- **Overscan mode**

This feature can be enabled to provide the optimal display size when displaying certain outputs on a television. Overscan mode is best for viewing movies or video clips. To avoid any blank or black margin around the edge of the television screen, this mode actually outputs an image that is slightly larger than the television display.

The NVIDIA implementation takes advantage of these features to provide enhanced operation:

- **Easy parameter setting capabilities**

Users can turn on/off the flicker filter and overscan features.

- **Optimized default values for television viewing**

The NVIDIA implementation sets default values for brightness and contrast settings, based on different video standards.

- **Slider control for overscan**

A slider adjustment lets users easily adjust the overscan mode to eliminate any black bars around the output display.

MPEG-2 Decoder

Video Mixer Renderer 9

The NVIDIA® ForceWare™ software architecture provides complete support for Microsoft Video Mixer Renderer functionality. VMR is a preferred alternative to the Windows Overlay Mixer, the original DirectShow component used on older versions of Windows to support video playback.

Applications that utilize VMR can combine multiple MPEG video streams for advanced video effects such as on-screen displays and picture-in-picture. VMR is a post-processing technique that is carried out after the MPEG-2 decoding stage. VMR then uses NVIDIA 3D texturing units to mix multiple video streams in a single pass, compared to the multiple passes that are required when using the Overlay Mixer. VMR is superior to the overlay mixer, allowing for:

- ❑ Better support for multiple displays (NVIDIA® nView™ multi-display capability) and multiple windows*
- ❑ Mixing of multiple video streams in one video window*
- ❑ Blending sub-picture data with the video in a single pass, rather than multiple passes required by the Overlay Mixer
- ❑ Support of picture-in-picture capability*
- ❑ The ability to blend on-screen displays with video for DVD player controls, information, or custom logos*

* *These features currently not available in Microsoft Windows XP Media Center Edition 2004*

ProcAmp Controls

An interface between the VMR and the graphics driver, the ProcAmp control extends the DirectX Video Acceleration (DXVA) 9.0 API to support ProcAmp control and post processing of video content by graphics drivers. If a driver supports accelerated decoding of compressed video, the VMR will call the driver to create two DXVA devices: one to perform the actual video decoding work, and the other to be used strictly for ProcAmp adjustments.

Using the ProcAmp controls, you can adjust brightness and contrast for improved viewing of any movie or video under any room lighting conditions. Additionally you can adjust the hue and saturation to eliminate conditions that make the output appear washed out or overly bright.

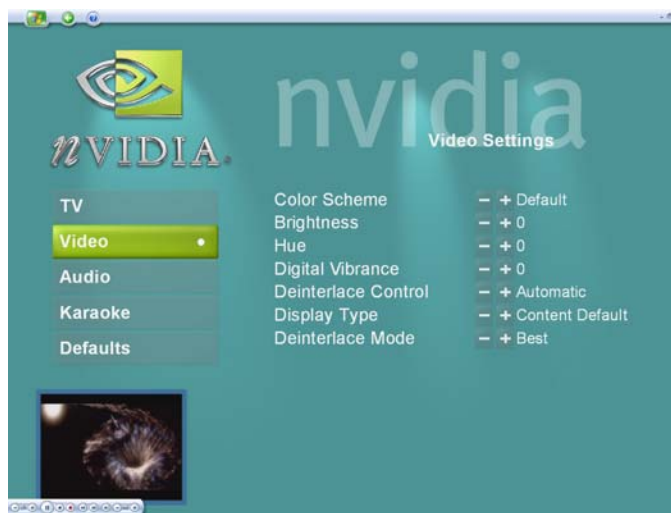
Remote Control

The NVIDIA MCE control settings enable end users to access the advanced NVIDIA graphics driver and MPEG-2 decoder settings using the remote control device. The remote control device makes it much more convenient to configure optimal listening and viewing conditions regardless of location. The following settings are user accessible with a remote control (see Figure 3):

- **TV** controls for size, position, etc.
- **Audio** controls for speaker setup, post processing, and dynamic range control
- **Video** controls for color, contract, brightness, de-interlacing, and Digital Vibrance settings
- **Karaoke** controls for karaoke encoded DVDs



Windows XP MCE 2004 start-up page with NVIDIA control settings.



NVIDIA control settings for video

Figure 3. Remote Control Settings Windows

Summary

The NVIDIA enhancements for Microsoft Windows XP MCE 2004 platforms provide functionality for improving the overall user experience related to video and television viewing. The NVIDIA enhancements improve:

- ❑ **Performance**

Complex color conversions are streamlined by combining multiple steps in the process, resulting in time savings and smoother output of streaming video.

- ❑ **Visual quality**

A full range of color (with uncompromised blacks and whites) enhances the user experience, and increased levels of precision in the pipeline avoid artifacts that would otherwise degrade the visual appearance on the display or television. The NVIDIA solution also addresses the differences between television screens and computer displays, and provides the capability to optimize output to both.

- ❑ **Control**

ProcAmp and VMR enhancements provide adjustability and features for a variety of viewing options.

- ❑ **Convenience**

Support for a remote control device makes the media center experience more familiar for users and simplifies user selections.

For combining the worlds of entertainment and computers, this attention to detail ensures that visual quality remains consistent and uncompromised, regardless of the output device in use, and effectively brings the worlds of television and PCs together.



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NVIDIA Corporation
2701 San Tomas Expressway
Santa Clara, CA 95050
www.nvidia.com