

## Video Playback Performance: A comparison of NVIDIA's PureVideo decoder on NVIDIA GeForce graphics adapters to ATI Radeon adapters, Intel 945G integrated graphics, and a variety of DVD players

### For NVIDIA Corporation

#### Executive summary

NVIDIA Corporation (NVIDIA) commissioned Principled Technologies (PT) to use the HQV Benchmark from Silicon Optix, Inc. to compare the DVD video playback performance of NVIDIA's PureVideo decoder on a set of three NVIDIA GeForce graphics adapters to the playback performance of seven other video sources. The other sources were three graphics adapters using ATI Technologies, Inc. (ATI) chipsets, the Intel Corporation (Intel) 945G integrated video chipset using an Intel ADD2 media expansion card, and three DVD players.

NVIDIA specified the graphics adapters and the processor for the test PC and provided the DVD players. PT specified the rest of the test PC's configuration, acquired its components and all the graphics adapters, and conducted all tests.

We tested the following graphics adapters and DVD players:

##### Graphics adapters based on ATI chipsets:

- ATI Radeon X850XT Platinum Edition 256MB GDDR2 PCI Express (connect3D Model No. 3025)
- ATI Radeon X600 Pro 256MB DDR PCI Express x16 (ABIT Model No. RX600PRO-HDTV)
- ATI Radeon X300SE 128MB DDR PCI Express x16 (ABIT Model No. RX300SE-Guru)

##### Integrated Intel graphics adapter:

- Integrated 945G chipset with the 950 Graphics Media Accelerator and Intel ADD2 Media Expansion PCI Express card

##### Graphics adapters based on NVIDIA chipsets:

- GeForce 7800GTX 256MB GDDR3 PCI Express x16 (Gigabyte Model No. GV-NX78X256V-B)
- GeForce 6600 256MB DDR PCI Express x16 (Gigabyte Model No. GV-NX66256DP)
- GeForce 6200 128MB DDR PCI Express x16 (Gigabyte Model No. GV-NX62128DP)

##### DVD Players

- Denon DVD-2910
- Samsung DVD-HD950
- Sony DVP-NS50P

#### Key findings

- ❖ The NVIDIA PureVideo Decoder on the three NVIDIA-based graphics adapters performed significantly better than the three ATI-based graphics adapters and decoders.
- ❖ The NVIDIA PureVideo Decoder on the three NVIDIA-based graphics adapters scored better than two of the three DVD players we tested.
- ❖ NVIDIA's PureVideo Decoder reduced the frequency of common de-interlacing issues and other video distortions due to common film cadences during DVD playback.

Silicon Optix Inc. (<http://www.siliconoptix.com>) develops high-end video and image digital processing integrated circuits. To evaluate the quality of video signal processing in various components, Silicon Optix developed the HQV Benchmark DVD (<http://www.hqv.com/benchmark.cfm>). This DVD walks the user through a variety of video content and test patterns that can reveal deficiencies in interlaced playback. These deficiencies include de-interlacing, jagged edges in diagonal lines ("jaggies"), decoding, motion correction, noise reduction, film cadence detection, and detail enhancement. We discuss these tests further in the Test methodology section below. The benchmark includes instructions on playback areas to examine and how to

rate a playback system to produce a score for each test. The tests are intentionally demanding; the HQV Benchmark instructions note that it is “a rare signal processor that can handle all of these tasks well.”

Figure 1 presents the cumulative results of our tests. The highest possible rating is 130. Each result is the sum of the individual test scores; those appear in the next section. (Some scores are N/A; the Test methodology section discusses the issues some video playback sources had with some test resolutions.)

Graphics adapter/DVD player	DVI connection (at 1080i or 720p)	Component connection (at 720p)	Component connection (at 480p)
<i>Graphics adapters</i>			
ATI Radeon X300SE <sup>(1)</sup>	35	N/A	N/A
ATI Radeon X600 Pro	35	40	N/A
ATI Radeon X850XT Platinum Edition	35	40	N/A
Intel 945G Integrated graphics with ADD2 Media Expansion <sup>(1)</sup>	25	N/A	N/A
NVIDIA GeForce 6200	66	71	N/A
NVIDIA GeForce 6600	68	73	N/A
NVIDIA GeForce 7800 GTX	68	73	N/A
<i>DVD players</i>			
Denon DVD-2910	85	81	N/A
Samsung DVD-HD950	43	N/A	43
Sony DVP-NS50P	N/A	N/A	41

**Figure 1: Summary results of the HQV Benchmark for each graphics adapter and DVD player we tested. The highest possible score is 130.**

As Figure 1 above shows, the Denon high-end DVD player produced the highest score, with the NVIDIA-based graphics adapters closest to it of the PC-based solutions. The three NVIDIA GeForce graphics adapters with the NVIDIA PureVideo Decoder scored far higher than the other adapters and beat two of the three DVD players. As the detailed results show, the NVIDIA advantage over the other ATI-based adapters was evident primarily in some of the jaggies tests, some of the film cadence tests, and the 3:2 film cadence detection test.

Standard definition TV and DVDs cannot broadcast video frames completely at one time. They require the use of two interlacing fields to create the image. Each interlacing field produces half of the image: the first presents the odd-numbered horizontal lines, and the second presents the even-numbered lines. The two fields alternate 60 times per second, creating the 30 frames-per-second (fps) NTSC broadcast standard. Motion pictures typically run at 24 fps. To convert a motion picture to the 30 fps rate for playback on a television, the studio broadcasting the motion picture or converting it to DVD must do several things. First, it must break down the frames of the motion picture into 48 interlacing fields, two for each of the 24 frames per second. Then, it must add interlacing fields to get to the total of 60 per second television uses. It does this by repeating one of the interlaced fields from every other frame of the motion picture. So for example, the first frame shows the odd numbered interlacing field, and then the even-numbered field. The second frame shows the odd-numbered interlacing field, the even-numbered field, and then the odd-numbered interlacing field again. This ratio, otherwise known as 2:3 cadence, repeats throughout the entire motion picture. The video processor, in this case, should be able to detect the extra interlacing field, and subsequently render the original frame by removing the extra interlacing field. The feature known as 3:2 pulldown refers to the correction the DVD player, television, or graphics adapter displaying such video provides to make the video source display smoothly.

The NVIDIA PureVideo Decoder on the NVIDIA GeForce graphics adapters detected cadence changes and adapted to them almost immediately, doing so in some cases even slightly faster than the high-end Denon DVD-2910 DVD player.

One of the significant differences in scores between the Denon DVD player and the NVIDIA-based adapters stems from the Denon's Dolby Noise Reduction feature, which eliminates video "noise" in playback. None of the PC graphics adapters or other DVD players provided this feature, so they all earned, per the HQV Benchmark instructions, a score of zero on the noise reduction test. The other significant difference occurred during the Waving Flag Test, which gauges the presence of jaggies and other interlacing issues in live footage of a flag waving in the wind. The Denon DVD player produced a perfect playback of the waving flag, with smooth lines in the stripes and the edges of the flag. The NVIDIA-based adapters produced almost perfect images, but they displayed a few jaggies.

The ATI Radeon-based graphics adapters as a group came in second to the NVIDIA-based adapters and also did well enough to score close to two of the three DVD players. Though the ATI-based graphics adapters generally produced detailed and clear pictures, we found interlacing issues that caused "jaggies" in diagonal lines, most notably in the Jaggies Pattern tests and the Waving Flag test. These adapters also had difficulties with cadence detection and all of the film cadence tests

## **Detailed test results**

This section details the results we collected for each graphics adapter and DVD player we tested with the HQV Benchmark. We group the results by the type of connection we used to hook the adapter or DVD player to the monitor.

### ***DVI connection***

We used the DVI connection to the monitor to test all but two of the adapters and DVD players at 1080i. The two exceptions were the Intel 945G integrated graphics chipset and the Sony DVP-NS50P DVD player. The Intel 945G integrated graphics chipset would not work with our test Samsung LCD HDTV at 1080i, so we tested it at 720p, the highest resolution at which it would work with the Samsung monitor. The Sony DVD player did not offer a DVI connection, so we could not run any of these tests on it.

The Samsung DVD-HD950 does not come with a DVI output, but we were able to run this test with it by using a cable, which came with the DVD player, that converted the HDMI output from the DVD player to a DVI input on the monitor.

Graphics adapter/DVD player	HQV Benchmark Test	Color Bar/Vertical Detail	Jaggies Pattern 1	Jaggies Pattern 2	Flag	Picture Detail	Noise Reduction	Motion Adaptive Noise Reduction	3:2 Detection	2-2 30 fps Video	2-2-2-4 DVCAM	2-3-3-2 DVCAM	3-2-3-2-2 Vari-Speed Broadcast	5-5 Animation	6-4 Animation	8-7 Anime	3-2 24 fps film	Mixed 3:2 Scrolling Test	Mixed 3:2 Credits	TOTAL (Maximum Score: 130)
<i>Graphics adapters</i>																				
ATI Radeon X300SE	5	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	10	10	35
ATI Radeon X600 Pro	5	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	10	10	35
ATI Radeon X850XT Platinum Edition	5	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	10	10	35
Intel 945G Integrated graphics with ADD2 Media Expansion	10	0	0	0	5	0	0	0	5	5	0	0	0	0	0	0	0	0	0	25
NVIDIA GeForce 6200	5	3	3	5	5	0	5	10	0	0	0	0	5	0	0	0	5	10	10	66
NVIDIA GeForce 6600	5	5	3	5	5	0	5	10	0	0	0	0	5	0	0	0	5	10	10	68
NVIDIA GeForce 7800 GTX	5	5	3	5	5	0	5	10	0	0	0	0	5	0	0	0	5	10	10	68
<i>DVD players</i>																				
Denon DVD-2910	5	5	5	10	5	5	5	10	5	5	0	0	0	0	0	5	10	10	85	
Samsung DVD-HD950	0	3	0	5	5	0	5	0	5	5	0	0	0	5	0	0	5	5	43	
Sony DVP-NS50P	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

**Figure 2: Detailed HQV Benchmark scores for tests using the DVI connection to the monitor.**

### **Component connection**

We used the component connection to the monitor to test all but four of the adapters and DVD players at 720p. The exceptions were the ATI Radeon X300SE adapter, the Intel 945G integrated graphics chipset, the Samsung DVD-HD950 DVD player, and the Sony DVP-NS50P DVD player. The ATI Radeon X300SE adapter and the Intel 945G integrated graphics chipset did not provide component connections. The Samsung DVD player worked only at 480p with the component connection, and the Sony DVD player could produce only the 480p resolution, so we tested both at that resolution.

Graphics adapter/DVD player	HQV Benchmark Test																		
	Color Bar/Vertical Detail	Jaggies Pattern 1	Jaggies Pattern 2	Flag	Picture Detail	Noise Reduction	Motion Adaptive Noise Reduction	3:2 Detection	2-2 30 fps Video	2-2-2-4 DVCAM	2-3-3-2 DVCAM	3-2-3-2-2 Vari-Speed Broadcast	5-5 Animation	6-4 Animation	8-7 Anime	3-2 24 fps film	Mixed 3:2 Scrolling Test	Mixed 3:2 Credits	TOTAL (Maximum Score: 130)
<i>Graphics adapters</i>																			
ATI Radeon X300SE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ATI Radeon X600 Pro	10	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	10	10	40
ATI Radeon X850XT Platinum Edition	10	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	10	10	40
Intel 945G Integrated graphics with ADD2 Media Expansion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NVIDIA GeForce 6200	10	3	3	5	5	0	5	10	0	0	0	5	0	0	0	5	10	10	71
NVIDIA GeForce 6600	10	5	3	5	5	0	5	10	0	0	0	5	0	0	0	5	10	10	73
NVIDIA GeForce 7800 GTX	10	5	3	5	5	0	5	10	0	0	0	5	0	0	0	5	10	10	73
<i>DVD players</i>																			
Denon DVD-2910	10	3	3	10	5	5	5	5	5	5	0	0	0	0	0	5	10	10	81
Samsung DVD-HD950 (at 480p)	0	3	0	5	5	0	5	0	5	5	0	0	0	5	0	0	5	5	43
Sony DVP-NS50P (at 480p)	10	3	3	5	5	0	5	0	0	0	0	0	0	0	0	0	5	5	41

Figure 3: Detailed HQV Benchmark scores for tests using the component connection to the monitor.

## Test methodology

We used all new components to assemble the test PC for the graphics adapter tests. We performed the following steps in building the system:

- Unpacked each component.
- Assembled them into a complete PC.
- Updated the BIOS.
- Installed the Windows XP Media Center operating system.
- Updated the operating system using Microsoft Windows Update.
- Updated the drivers for the integrated Intel 945G graphics subsystem from Intel's Web site.

We then used Symantec's Ghost product to capture an image of this initial state of the system's hard disk.

For each of the six add-on graphics adapters we tested, we installed the adapter, updated its drivers, and then made a Ghost image of the system's disk.

We used the same monitor for all the tests: a Samsung 22-inch High Definition LCD TV (Model LTP227W). To maintain a neutral display and to make sure we tested only the performance of the DVD player or graphic adapter, we used the following settings for the monitor:

- Picture Mode: Standard
- Color Tone: Standard
- Size: Wide
- DNle (Digital Natural Image engine): Off

Whenever possible, we tested with two different connections between the graphics adapter or DVD player and the monitor: DVI, and the component connection (YPbPr).

For the graphics adapter tests, whenever possible we tested at two high-definition (HD) resolutions: 720p with the component connection, and 1080i for the DVI connection. For the DVD player tests, we tested the component connection at 720p whenever possible. With the DVI connection, we tested at the 1080i resolution whenever possible. Figure 4 details exactly the connections and resolutions we used in testing each graphics adapter and DVD player.

Graphics adapter / DVD player we tested	Connection type	
	DVI	Component (YPbPr)
<i>Graphics adapters</i>		
ATI Radeon X300SE	1080i	N/A
ATI Radeon X600 Pro	1080i	720p
ATI Radeon X850XT Platinum Edition	1080i	720p
Intel 945G Integrated graphics with ADD2 Media Expansion	720p	N/A
NVIDIA GeForce 6200	1080i	720p
NVIDIA GeForce 6600	1080i	720p
NVIDIA GeForce 7800 GTX	1080i	720p
<i>DVD players</i>		
Denon DVD-2910	1080i	720p
Samsung DVD-HD950 <sup>(1)</sup>	1080i	480p
Sony DVP-NS50P	N/A	480p

(1) For the DVI connection test on the Samsung DVP-NS50P, we used a cable, which came with the DVD player, that converted the HDMI output from the DVD player to a DVI input on the monitor. The Samsung DVD-HD950 does not come with a DVI output.

**Figure 4: The test connection and resolution settings for each graphics adapter and DVD player.**

### ***Testing with the HQV benchmark***

For each configuration we tested, we ran all 18 tests in the HQV Benchmark, which is a product of Silicon Optix, Inc. The HQV Benchmark DVD walks the user through a variety of video content and test patterns that may reveal deficiencies in video playback. We followed the HQV Benchmark instructions for scoring each test.

To avoid the possibility that a single tester's perceptions might yield inaccurate results, two different testers ran the complete suite of tests on every test configuration (graphics adapter or DVD player, connection type, and resolution). Each tester conducted the test independently without interacting with the other tester and with no knowledge of the other tester's scores.

After the two testers completed all the tests, we compared their scores for each device. The testers then discussed each difference and retested if necessary. We had planned to involve a third tester to resolve the differences, but in all test cases, the two testers were able to arrive at a consensus on any differences that occurred in the course of this project. We note these occurrences in the summary of test phases below.

We summarize each of the tests below. For more details, refer to a PDF document that Silicon Optix provides at <http://www.hqv.com/benchmark.cfm>.

#### Test 1: Color Bar/Vertical Detail

This test examines how each DVD player or graphics adapter handles vertical resolutions and de-interlacing. The HQV Benchmark presents a test pattern on the screen.

The rating depends on an area of the screen where small horizontal lines are stacked in a column. Any flickering in this area or loss of detail or definition lowers the score. We gave a score of 10 if the lines were detailed and did not show any flickering. We gave a score of 5 if the lines were detailed, but showed some flickering. We gave a score of 0 if the lines were no longer discernable.

This test also presents several color bars in case testers need to make any television/monitor adjustments. We did not need to make any adjustments.

#### Test 2: Jaggies Pattern 1

This test further addresses interlacing quality by presenting an image of a circle and a line spinning clockwise in the circle's center. As the line spins and moves from a 45-degree angle to a horizontal position and then down to a -45 degree angle, "jaggies" may appear along the line's edge. Jaggies are staggered or stepped lines that appear instead of a smooth line. As the line spins and moves through the 45 to -45 degree area, the HQV Benchmark designates three zones along the side of the circle: red, yellow, and green. The red zone covers from 45 to 20 degrees and from -20 to -45 degrees. The yellow zone covers from 20 to 10 degrees, and from -10 to -20 degrees. The green zone covers from 10 to -10 degrees.

The occurrence of jaggies and the zone in which they appear during the line's rotation determine the score. We gave a score of 5 if jaggies did not appear or appeared in the green zone. We gave a score of 3 if jaggies appeared in the yellow zone. We gave a score of 0 when jaggies occurred in the red zone.

#### Test 3: Jaggies Pattern 2

This test is similar to the Jaggies Pattern 1 Test above. The HQV Benchmark displays the same circle, but with three short lines at slightly different angles inside the upper right portion of the circle. These three lines quickly move back and forth across a short distance along the inside of the circle.

The score depends on which and how many of these lines appear to have jaggies along their edges. We gave a score of 5 if we did not see any jaggies. We gave a score of 3 if jaggies appeared only on the bottom line. We gave a score of 1 if jaggies appeared on the bottom two lines. We gave a score of 0 if jaggies appeared on all three lines.

#### Test 4: Waving Flag

This is the benchmark's first live-video test. This test displays a flag waving in front of a brick building. The tester examines the flag as it waves to see if any jaggies appear. The tester also checks the bricks of the building to see if the display drops any details.

We gave a score of 10 if we did not see any jaggies in the flag and we saw details in the bricks of the building. We gave a score of 5 if we saw slight jaggies in the flag and some details in the bricks of the building. We gave a score of 0 if the interlacing issues were pronounced and we saw a significant loss of details in the bricks of the building.

## Test 5: Picture Detail

This test assesses the level of detail the video processor can generate in a live-action video that displays a street in the middle of the screen, a section of grass along its right side, and a set of stone stairs leading up to a gold statue of a man riding a horse on its left. The background is a stone bridge over the street in the center.

The score depends on the quality of the details in three parts of the video--the grass along the road, the stone bricks in the bridge, and the gold statue above the stone stairway—as well as on whether jaggies appeared in the lines of the steps of the stone stairway.

The two testers had to discuss the degree of detail and clarity in the picture that would merit a score of 10 rather than 5. We decided that to get a score of 10 the playback had to be perfect, with no issues in the definition of all of the objects in the video, including the grass field, the stone bricks in the bridge, and the gold statue. (Jaggies in the stone stairs were easy to detect and the testers always agreed on them.)

We felt that this interpretation of results was within the bounds of the HQV Benchmark rating system. We gave a score of 10 if we found clear and sharp details in the grass field, the stone bricks of the bridge, and the gold statue, and there were no jaggies in the stone stairs. We gave a score of 5 if we saw sufficient, but not sharp details in the above items, and we found no jaggies in the stone stairs. We gave a score of 0 if we saw minimal details in the above objects and found some jaggies in the stone stairs.

## Test 6: Noise Reduction

This test evaluates the ability of the video processor to reduce video noise that appeared in the video from NTSC standard broadcasts. The test plays video footage of various outdoor scenes with little or no movement. Each bit of footage contains typical video noise interference. Such noise commonly results from copying or editing of the original source or interference in television reception and broadcast. Video noise is most frequently visible in footage that contains broad areas of solid colors, such as scenes showing clear skies, and especially with darker colors, such as outdoor scenes shot at night.

Our testers discussed the significance of this test in relation to our DVD playback testing. Because copies of video tapes or interference through television broadcasts usually causes this type of video noise, this phase of the test appeared to have little bearing on evaluating the abilities of a graphics adapter or a DVD player. We saw this as more of a test for televisions or video monitors.

Only the Denon DVD player provided Dolby Noise Reduction for video. Therefore, in accordance with the HQV Benchmark instructions, this meant an automatic score of 0 for all the other video processors we tested. We gave a score of 5 to the Denon DVD player, because of its built-in Dolby Noise Reduction and a noticeable reduction of the video noise without losing image detail, which is also described in the HQV Benchmark rating system. (To earn a 10, the video processor would have had to significantly reduce video noise without any associated loss in details in the image.)

## Test 7: Motion Adaptive Noise Reduction

Similar to Test 6 above, this test assesses the video processor's noise reduction capabilities. This test displays video with high-speed movement: a rollercoaster in action filmed at different locations of the track, and a boat moving down a river in the middle of a city.

The benchmark's instructions in this case did not state that a video processor earned a score of 0 automatically if it lacked Dolby Noise Reduction. We consequently felt that this test focused more on how well each video processor played back footage that contained fast-moving action and video noise. We thus based our scoring decisions primarily on the degree of blurriness in the motion of the roller coaster and the riverboat. We also used the level of video interference in the sky as a secondary judging point. Therefore, we felt that we scored with more emphasis on the objects in motion than video noise reduction as the HQV Benchmark rating system intended.



We gave a score of 10 when we saw sharp detail in both the roller coaster and riverboat and very little video noise in the sky. We gave a score of 5 if we saw some blurriness in the roller coaster and riverboat and noticeable video noise in the sky. We gave a score of 0 if we saw severe blurriness and trails in the roller coaster and the riverboat and significant video noise in the sky.

#### Test 8: 3:2 Detection

This test measures the video processor's ability to recognize the type of cadence on the DVD. (We discussed cadence in the Executive summary.) The video processor in the DVD player, graphics adapter, or television/monitor should recognize the shift in film cadence, for example, a 2:3 cadence when playing a motion picture originally shot at 24 fps. Once the video processor correctly detects the extra interlacing field, it will subsequently render the original frame by removing this extra interlacing field. Otherwise, the picture clarity can suffer.

To assess this ability, the HQV Benchmark plays video footage of an Indy 500 racecar speeding alongside a section of bleachers next to the racetrack originally shot in 24 fps and using the 3:2 film cadence. If the video processor does not use the proper cadence, the bleachers appear distorted and unclear. This is called a moiré pattern, where overlapping repetitive lines can cause flickering and distracting images.

In accordance with the HQV Benchmark rating system, we evaluated two key criteria: whether the video processor detected the 3:2 film cadence and produced a clear image, and how quickly it detected this cadence. We gave a score of 10 if we saw sharp details in the bleachers and if the video processor detected the 3:2 cadence immediately. We gave a score of 5 if we saw sharp details in the bleachers, but the video processor did not detect the cadence until the racecar was halfway past the bleachers. We gave a score of 0 if the bleachers appeared to flicker (moiré pattern) and the video processor did not detect the 3:2 film cadence.

#### Test 9: Film Cadence

This test, which lets testers further assess how well the video processor handles changes in cadence, is actually eight tests in one. The benchmark plays a video of a man reading a newspaper at a counter in a diner. The camera moves in as he reads and shifts the newspaper. The HQV Benchmark plays this same footage repeatedly, but with differing cadences. The cadences listed below are similar to the 2:3 cadence, where the first frame uses two interlacing fields, then the second uses two while repeating the odd-numbered field, and the pattern repeats throughout the motion picture. In each case below, the numbers represent how often each interlaced field repeats and in which frame pattern:

- 2:2 – the cadence resulting from video shot at 30 fps, the same as the NTSC standard broadcast
- 2:2:2:4 and 2:3:3:2 – the cadences resulting from video shot at 24 fps using professional Digital Video (DV) camcorders and High Definition Video (HDV) camcorders
- 3:2:3:2:2 – the cadence resulting from television broadcasts that compress motion pictures into a two-hour time frame while leaving ample time for commercials
- 5:5 and 6:4 – the cadences resulting from broadcasting animation features, which are typically filmed at 12 fps
- 8:7 – the cadence resulting from broadcasting Japanese Anime movies, which are typically filmed at 8 fps
- 3:2 – the cadence resulting from broadcasting motion pictures, which are filmed at 24 fps

In each test phase, the tester examines the lines along the edges of the newspaper to see if any jaggies are visible and to see if the video loses any details in the newspaper print from the presence of moiré interference. The tester also looks at the coffee cups on the counter in front of the man to see if they show any additional jaggies or flickering along their edges, the lines around their rims, or near their bases.

As the HQV Benchmark instructions specify, we scored a 0 on each film cadence test if we saw any jaggies along the newspaper edges, any jaggies or flickering in the coffee cups, or any detail loss or moiré issues in

the newspaper print. If we saw none of the above playback issues in all three of the above areas, we gave a score of 5. We noted visible differences among some of the products that scored 0 on some of these tests, but the benchmark's instructions provided no way for us to differentiate among those products.

#### Tests 10 and 11: Mixed 3:2 Film Mixed With Added Video Titles

This test also displays footage using the 3:2 film cadence ratio, but this time with some on-screen text: a text crawl along the bottom of the screen in Test 10, and a credit listing along with the video in Test 11. Test 10 simulates the type of text crawl often playing on 24-hour news broadcasts, and Test 11 simulates the credits at the end of a movie.

The score depends on how well the video processor displays the movie, such as the presence of jaggies or loss of details in the objects, and the clarity of the letters as they move horizontally and vertically across the screen. We gave a score of 10 when the letters appeared smooth and clear without any interlacing issues, and there were no jaggies or loss of definition and detail in the video. We gave a score of 5 if the letters appeared smooth and clear without any interlacing issues, but we saw some jaggies or loss of detail in the video. We gave a score of 0 if the letters were not smooth and had interlacing issues and the video showed some loss of detail.

### ***Viewing distance for the tests***

The viewing distance is obviously a critical factor in any video playback test. Our goal was to conduct the test at a distance from which a typical consumer might watch video on this monitor. Crutchfield New Media LLC is an audio, video, and home theater dealer that offers a wide variety of electronic equipment to consumers, and its Web site (<http://www.crutchfieldadvisor.com>) recommends that consumers watch an HDTV monitor from a distance that is approximately 2.5 times the size of the diagonal measurement of the screen. This recommendation matched our own experiences, so we tested from a viewing distance of 55 inches (2.5 times the 22-inch diagonal measurement of our test monitor.)

### ***System setup and configuration details***

We partitioned the test PC's hard disk into a 50GB NTFS partition for the operating system and a 30GB NTFS partition for Ghost images of each operating system installation with each graphics adapter.

We updated the BIOS on the Intel 945G motherboard with the latest version available as of the start of this test: NT94510J.86A.1788.2005.0728.1510, dated 8/4/2005. We downloaded that BIOS from Intel's Web site ([http://downloadfinder.intel.com/scripts-df-external/filter\\_results.aspx?strTypes=all&ProductID=2064&OSFullName=Windows\\*+XP+Media+Center+Edition&lang=eng&strOSs=88&submit=Go%21](http://downloadfinder.intel.com/scripts-df-external/filter_results.aspx?strTypes=all&ProductID=2064&OSFullName=Windows*+XP+Media+Center+Edition&lang=eng&strOSs=88&submit=Go%21)).

After we installed the Microsoft Windows Media Center Edition operating system, we went through the following process the first time we booted it:

1. Pressed Next to set up Windows XP.
2. Answered "Yes" to "Do you hear music playing out of the speakers?"
3. Selected United States, English, and U.S. keyboard.
4. Selected Eastern Time.
5. Selected "Yes" to both the manufacturer (if present) and Microsoft End User License Agreements.
6. Selected "No" to automatic updates, because we wanted to manually perform the updates before testing and thus be certain we used the same updates with each graphics adapter.
7. We named the computer DVDPLAYER.
8. We left the machine description blank.
9. Selected "Skip" during the "How will this computer connect to the Internet?" part of the setup process.
10. Selected "No" to registering with Microsoft.

11. Selected "Finish".

We then ran the Windows Update feature through Microsoft's Web site (<http://windowsupdate.microsoft.com>). Appendix D lists all the Windows updates we applied on 08/31/2005.

We then used Symantec's Ghost product to capture an image of the operating system partition and stored it on the 30GB partition.

We then installed each individual graphics adapter and applied the latest driver updates available from the Web site of the manufacturer of that adapter's graphics chipset. Once we applied all of the updates, we used Symantec's Ghost again to capture the image and stored that image on the 30GB partition.

Before we installed the next card, we applied the original clean image to ensure no intermingling of the graphics adapter and driver installations among the graphics adapters.

### ***Graphics adapter drivers***

We used the following drivers for the graphics adapters in this report:

ATI

- Radeon X300SE, X600 Pro, X850XT Platinum Edition – Version 8.162, dated 8/17/2005 (Catalyst 5.8)
- Source: <https://support.ati.com/ics/support/default.asp?deptID=894&task=knowledge&folderID=294>

Intel

- Intel Graphics Media Accelerator 950 – Version 14.15.0.4363, dated 8/3/2005
- Source: [http://downloadfinder.intel.com/scripts-df-external/filter\\_results.aspx?strTypes=all&ProductID=2064&OSFullName=Windows\\*+XP+Media+Center+Edition&lang=eng&strOSs=88&submit=Go%21](http://downloadfinder.intel.com/scripts-df-external/filter_results.aspx?strTypes=all&ProductID=2064&OSFullName=Windows*+XP+Media+Center+Edition&lang=eng&strOSs=88&submit=Go%21)

NVIDIA

- GeForce 6200, 6600, 7800GTX – Version 7.7.7.7, dated 7/20/2005 (ForceWare 77.77)
- Source: <http://nvidia.com/content/drivers/drivers.asp>

### ***Graphics adapter DVD decoders***

We tested whenever possible with the DVD decoder the graphics chipset vendor recommended.

ATI

We attempted to install the DVD decoder that ATI recommends and that appears to be available on ATI's Web site. That decoder did not work with the three ATI-based graphics cards we purchased. The ATI Web site (<https://support.ati.com/ics/support/default.asp?deptID=894&task=knowledge&folderID=27>) explained the issue as follows:

"An ATI Decoder Update Wizard (580KB) is first used to validate a supported original ATI Install CD. Once validated, the download of DVD Decoder will begin."

We downloaded and attempted to run the update wizard. A message box appeared stating that we did not have a valid installation CD. This occurred despite the fact that we used the same installation CD that accompanied each ATI Radeon-based graphics adapter.

We contacted ATI Tech Support through email to find a solution to the problem. The response was that even though we have an installation CD for each of our Radeon-based graphics adapters, we had to purchase the ATI All-in-Wonder X800XT installation disc from the ATI Web site (<http://shop.ati.com/product.asp?sku=2634250>). This disc would allow us to run the ATI Decoder update utility. We purchased this disc, put it in the system's CD-ROM drive, and ran the same utility. We were then able to download the latest DVD decoder from ATI's Web site.

Intel

The Intel motherboard did not come with a DVD decoder. We could find no recommendation on Intel's Web site for a DVD decoder to use with the 945G integrated graphics adapter. We found some recommendations on Intel's Web site for CyberLink DVD decoders, as well as for those from other companies, for other motherboards. We consequently decided to use CyberLink's PowerDVD version 6.0 as the DVD decoder for tests involving the Intel integrated graphics chipset.

NVIDIA

NVIDIA's Web site recommends its PureVideo decoder. We downloaded a trial version (04.02-150) of that decoder from the NVIDIA Web site ([http://www.nvidia.com/object/dvd\\_decoder\\_1.02-150-trial.html](http://www.nvidia.com/object/dvd_decoder_1.02-150-trial.html)). Once we installed it and rebooted the system, the PureVideo Decoder automatically launched each time we played back a DVD with either Windows Media Player or Windows Media Center.

### ***Graphics adapter configurations for the HQV Benchmark***

After we installed each adapter's driver and DVD decoder, we used the following steps to set the system to the appropriate configuration for the HQV Benchmark.

We downloaded and installed Microsoft's Windows XP Video Decoder Checkup Utility (<http://www.microsoft.com/downloads/details.aspx?FamilyID=de1491ac-0ab6-4990-943d-627e6ade9fcb&displaylang=en>). This utility checks the MPEG-2 decoders currently installed on the system and determines whether they are compatible with Windows Media Player 10 and Windows XP Media Center. This utility lets the user designate which of the Windows-approved MPEG-2 decoders to use when playing DVDs.

ATI

We performed the following steps:

1. Click Start->Programs->Windows Media->Microsoft Windows XP Video Decoder Checkup Utility
2. In the Microsoft Windows XP Video Decoder Checkup Utility window, the following MPEG-2 decoder appears:
  - o Decoder Vendor: CyberLink Video/SP Decoder (ATI)
  - o Decoder File Name: CLVSD.ax
  - o Decoder Version: 6.0.0.1311
  - o Compatible: MP10 and MCE
3. Highlight this item.
4. Click Set as Preferred at the bottom of the window
5. Click Close to close the window.

We then used the ATI Catalyst Center to make further configuration and resolution changes. The ATI Radeon driver installation included the ATI Catalyst Center. We followed this process to make those changes:

1. Double-click the ATI Catalyst Control Center icon on the Windows Desktop
2. Click View at the top, and select Advanced View

3. Under Video, click on Deinterlacing.
4. In the pull-down menu in the Deinterlacing Settings box, select Auto-detect (Recommended).
5. For tests involving the DVI connection, we did the following:
  - A. Under Digital Panel Properties, click HDTV Support.
  - B. Check the boxes next to Add 1080i standard format to the Displays Manager.
  - C. In the Predefined and Custom HDTV Formats section, highlight the resolution 1080i custom (1776 x 1000 @ 30Hz).
6. For tests involving the component connection, we did the following:
  - A. Under Component Panel Properties, click HDTV Support.
  - B. Check the boxes next to Add 720p standard format to the Displays Manager/
  - C. In the Predefined and Custom HDTV Formats section, highlight the resolution 720p custom (1152 x 648 @ 60Hz).
6. Click Apply Format.
7. Click OK at the bottom to close the ATI Catalyst Control Center.
8. Reboot the system before running the HQV Benchmark.

## Intel

The Intel 945G motherboard we used in our system, the D945GNT, comes with the Intel Graphics Media Accelerator 950 graphics core (<http://www.intel.com/design/motherbd/nt/>). Intel's Web site states that the Graphics Media Accelerator 950 graphics core can support HDTV resolutions up to 1080i and 1080p (<http://www.intel.com/products/chipsets/gma950/>). In our configuration, however, because we were using the Samsung 22" LCD HDTV through an Intel ADD2 media expansion card, we could not increase our resolution past 720p (1280x720). The motherboard did come with a graphics adapter configuration application, but it did not provide configuration settings for standard HDTV formats. We searched Intel's Web site but could not find any additional downloads that would let us test with 1080i.

We contacted Intel's tech support through email for more information. The response stated that the lack of HDTV resolution settings was due to the Samsung LCD HDTV we were using and we should download a driver from Samsung's Web site that would enable the resolution we wanted. We searched Samsung's Web site but could not find any drivers for any of their LCD TVs. According to the FAQ section at [http://erms.samsungusa.com/customer/sea/jsp/faqs/faqs\\_ars\\_input.jsp?PROD\\_SUB\\_ID=41&PG\\_ID=3](http://erms.samsungusa.com/customer/sea/jsp/faqs/faqs_ars_input.jsp?PROD_SUB_ID=41&PG_ID=3),

"All computer compatible Samsung TVs are Plug and Play compatible. This means that your Windows PC system automatically detects and configures itself to display on your Samsung TV. You do not need to install additional drivers."

We connected a standard CRT monitor to our test system and were able to increase the resolution to the maximum setting of 2048 x 1536 @ 75Hz. We could not, however, set the resolution to any standard HDTV interlaced format.

Consequently, we tested the Intel 945G integrated graphics chipset with Intel ADD2 media expansion card at the maximum standard HDTV resolution we could achieve, 720p. This was the default resolution setting for our installation of Microsoft Windows XP Media Center 2005, so we did not need to make any resolution configuration changes.

We followed this process to configure CyberLink PowerDVD for testing with the Intel 945G integrated graphic adapter:

1. Double-click the CyberLink PowerDVD icon on the Windows Desktop.
2. Click the Configuration button.
3. Click the Video tab.
4. Click Advanced....
5. Under the Smart De-Interlacing Mode, check the box next to Perform de-interlacing.
6. Click the radio button next to Auto-select.
7. Click OK to exit the configuration window.

8. Reboot the system before running the HQV Benchmark.

## NVIDIA

We followed this process to configure Windows Media Center:

1. Open Windows Media Center.
2. Click the Tools pull-down menu, and select Options.
3. Click the Performance tab.
4. Click the Advanced... button at the bottom.
5. In the Video Acceleration Settings window, check the boxes next to Use video mixing render and Use overlays in the Video Acceleration section.
6. In the DVD video section, uncheck the boxes next to Use the video mixing renderer, Use overlays, and Enable full-screen mode switch.
7. Click OK.
8. Click OK to close the Windows Media Player Options window.

We next configured the NVIDIA PureVideo Decoder as follows:

1. While playing a DVD, the NVIDIA PureVideo Decoder icon appears in the Windows system tray.
2. Right click on the icon, and select Decoder Properties.
3. In the NVIDIA PureVideo Decoders Properties windows, make sure the following settings have the values we indicate:
  - o In the Display Type section, select Content default.
  - o Check the box next to "Hardware acceleration".
  - o Under De-interlace Control, select Automatic.
  - o Under De-interlace Mode, select Best available.
  - o Under TV Overscan Correction, select 0 next to "Zoom Out %".
  - o Under Enhanced nView support, select "Prefer Overlay".
4. Click OK

We used the NVIDIA GeForce software utility to make resolution changes as follows:

1. Right-click anywhere on the Windows desktop and select Properties.
2. Click the Settings tab, and select click on Advanced....
3. Click the GeForce tab, which opens the NVIDIA configuration window.
4. Under Screen Resolutions & Refresh Rates, check the box next to Show Standard HDTV formats.
5. At the Advanced Timing license agreement, page down the text, and click I accept.
6. Under nView Display Settings, click Device Settings.
7. In the pull-down menu, select Select TV format, and select 1080i HDTV (DVI connection) or 720p HDTV (Component connection), as appropriate for the test.
8. Click Apply.
9. In the HDTV Overscan Compensation screen, select Underscan.
10. Click OK.
11. Click OK at the Display Settings message box.
12. When the screen returns after making the resolution change, click OK to close the Display Properties Box.
13. Reboot the system before running the HQV Benchmark.

## Common configuration settings

Other than the configuration changes we noted above, we left all other settings at their default values. Figure 5 details the most important settings we used for the HQV Benchmark tests for the products from each chipset vendor.

Configurations	ATI Radeon	Intel 945G	NVIDIA GeForce
Resolution (DVI)	1080i standard HDTV format	720p (1280x720)	1080i standard HDTV format
Resolution (Component)	720p standard HDTV format <sup>(1)</sup>	N/A	720p standard HDTV format
Deinterlacing	Auto-detect (recommended)	Smart	Smart
Dolby Noise Reduction	N/A	N/A	N/A

(1) One ATI-based adapter, the ATI Radeon X300SE, did not come with a component connection.

**Figure 5: Common configuration settings, by chipset vendor, for the graphics adapters we tested.**

### ***DVD player configuration***

We tested each DVD player in a configuration the HQV Benchmark recommended. In almost all cases, we left the DVD players' settings at the default and original values. The only changes we made to each DVD player were their Dolby Noise Reduction level settings (if available) and the resolution for each connection (480p and 1080i). Figure 6 shows the values of the most relevant and common settings for all three DVD players.

Configurations	Denon DVD-2910	Samsung HD950	Sony DVP-NS50P
Dolby Noise Reduction	+3 (on a scale from 0 to +6)	N/A	N/A
TV Type	16:9	16:9	16:9
TV Output	Wide	Wide	Full
Black Level	Normal	On	On
Video Output	Progressive	HDMI/Component (P-Scan)	Progressive
DVI Output	N/A	Mode A	N/A
Progressive Mode	AUTO2	N/A	N/A

**Figure 6: Common configuration settings for the three DVD players we tested.**

## Appendix A: Test system configuration information

This appendix provides detailed configuration information about the test system we built.

<b>General</b>	
Processor and OS kernel: (physical, core, logical) / (UP, MP)	1P2C2L / MP
Number of physical processors	1
Single/Dual Core processors	Dual Core
Processor HT Status	N/A
System Power Management Policy (AC/AlwaysOn, AC/Adaptive, DC/AlwaysOn, DC/Adaptive, Other)	AC / AlwaysOn
<b>CPU</b>	
Segment (S=Server, D=Desktop, M=Mobile)	D
Vendor	Intel
Name	Pentium D
Model number	Pentium D 820
Stepping	4
Socket type and number of pins	LGA775
Core frequency	2800
Front-side bus frequency	800MHz
L1 Cache	12KB+16KB
L2 Cache	2x1MB
<b>Platform</b>	
Vendor	Intel
Motherboard model number	BOXD945GNTKR
Motherboard chipset	Intel 945G
Motherboard revision number	AA C96320
System/motherboard serial number	BTNT52700684
Bios name and version	Intel NT94510J.86A.1788.2005.0728.1510
BIOS settings	Default
Chipset INF driver	Intel 7.0.0.1017
<b>Memory module(s)</b>	
Vendor and model number	Kingston HyperX KVR533D2E4/512
Type	PC2 4200 DDR2-SDRAM 240-pin
Speed (MHz)	533
Speed running in the system (MHz)	266
Timing/Latency (tCL-tRCD-tRP-tRASmin)	4-4-4-12
Size	1024MB
Number of sticks	2 x 512MB
Chip organization (Single-sided, Double-sided)	Single-sided
Channel (Single/Dual)	Dual
<b>Hard disk</b>	
Vendor and model number	Western Digital Caviar SE WD800JD
Size	80GB
Buffer Size	8MB
RPM	7200 RPM
Type	Serial ATA 1.5
Controller	Intel 82801GB (ICH7R) Serial ATA Storage Controller
Driver	Intel 7.0.0.1020



<b>Operating system</b>	
Name	Windows XP Media Center Edition
Build number	2600
Service pack	SP2
File system	NTFS
Kernel	ACPI Multiprocessor PC
Language	English
Microsoft DirectX version	DirectX 9.0c
<b>Graphics</b>	
Vendor and model number	(see Appendix B for all graphics adapter details)
<b>Sound card/subsystem</b>	
Vendor and model number	SigmaTel STAC9220
Type (P=PCI, I=Integrated)	I
Driver	SigmaTel 5.10.4647.0
<b>Network card/subsystem</b>	
Vendor and model number	Intel 82573V 10/100Mbps
Type (P=PCI, I=Integrated)	I
Driver	Intel 9.1.30.0
<b>Optical drive(s)</b>	
Vendor and model number	LITE-ON DVD-ROM Model SOHD-16P9SBLK
Type (CDROM, CDRW, DVD-ROM, DVD-W)	16X DVD-ROM, 48X CD-ROM, IDE
Interface (I=Internal, E=External)	I
<b>USB ports</b>	
Number	6 (2 on the front; 4 on the back)
Type	2.0
<b>Monitor</b>	
CRT/LCD type (P=Plug & Play, T=TFT, R=Reflective)	P
CRT/LCD refresh rate	60 Hz
Other information	Samsung 22" LCD TV, Model LTP227W

**Figure 7: System configuration information for the test system we built.**

## Appendix B: Graphics adapter configuration information

This appendix provides detailed configuration information for each of the graphics adapters we tested.

	ATI Radeon RX300	ATI Radeon RX600PRO	ATI Radeon X850XT PE	Intel 945G (950 GMA)	NVIDIA GeForce 6200	NVIDIA GeForce 6600	NVIDIA GeForce 7800 GTX
<b>Model</b>							
Brand	ABIT	ABIT	connect3d	Intel	GIGABYTE	GIGABYTE	GIGABYTE
Model	RX300 SE-PCIE	RX600Pro-HDTV	3025	I945G	GV-NX62128DP	GV-NX66256DP	GV-NX78X256 V-B
<b>Chipset</b>							
GPU	Radeon X300SE	Radeon X600PRO	Radeon X850XT PE	GMA950	GeForce 6211	GeForce 6600	GeForce 7800GTX
Core clock	325 MHz	400 MHz	540 MHz	400 MHz	300 MHz	300 MHz	430 MHz
Pixel pipelines	4	4	16	4	4	8	24
<b>Memory</b>							
Memory Clock	400 MHz	600 MHz	1180 MHz	266 MHz	500 MHz	550 MHz	1200 MHz
Memory size	128 MB	256 MB	256 MB	128 MB	128 MB	256 MB	256 MB
Memory Interface	128-bit	128-bit	256-bit	256-bit	128-bit	128-bit	256-bit
Memory type	DDR	DDR	GDDR3	DDR2	DDR	DDR	GDDR3
<b>3D API</b>							
DirectX	9	9	9	9	9	9	9
OpenGL	2.0	1.5	2.0	1.4	1.5	1.5	2.0
<b>Interface</b>							
Interface	PCI Express x16	PCI Express x16	PCI Express x16	PCI Express x16	PCI Express x16	PCI Express x16	PCI Express x16
<b>Ports</b>							
D-SUB	1	1	0	0	1	1	
DVI	1	1	2	1	1	1	2
TV-Out	S-Video / Composite	S-Video/ Composite/ Component	S-Video/ Composite/ Component	S-Video/ Composite/ Component	S-Video/ Composite/ Component	S-Video/ Composite/ Component	S-Video/ Composite/ Component
VIVO	No	No	Yes	No	No	No	Yes
<b>General</b>							
RAMDAC	400 MHz	400 MHz	400 MHz	400 MHz	400 MHz	400 MHz	400 MHz
Max resolution	2048 x 1536 @ 85Hz	2048 x 1536 @ 85Hz	2048 x 1536 @ 85Hz	2048 x 1536 @ 75Hz	2048 x 1536 @ 85Hz	2048 x 1536 @ 85Hz	2048 x 1536 @ 85Hz
SLI supported	No	No	No	No	No		Yes
Microsoft Windows versions supported	Windows 98/Me/NT 4.0/2000/XP	Windows 2000/XP	Windows 2000/XP	Windows 2000/XP	Windows 2000/XP	Windows 2000/XP	Windows 2000/XP

Figure 8: Configuration information for all the graphics adapters we tested.

## Appendix C: Prices for the graphics adapters and DVD players

This appendix provides the prices for the graphics adapters and DVD players we tested. The graphics adapter price listings include the source of each adapter and the price we paid. Because NVIDIA provided the DVD players, we list for each of them the manufacturer's Web site and Manufacturer's Suggest Retail Price (MSRP). Samsung did not provide this information for the DVD-HD950. In its place, they provided a link to locate a local retail store by zip code. After entering our zip code, Samsung's Web site listed three stores: Sears, Best Buy, and Tweeter. We checked the Web sites of each of these stores for this model. None of the above stores had the Samsung DVD-HD950 in stock. As a result, we turned to a popular price search engine, Froogle.com, and found approximately 20 listings of stores selling this specific model. We used the median price from those listings in Figure 9 below.

	Source	Price
<i>Graphics adapters</i>		
ATI Radeon X300SE	Newegg.com	64.00
ATI Radeon X600 Pro	Newegg.com	112.00
ATI Radeon X850XT Platinum Edition	Newegg.com	469.00
Intel 945G Integrated graphics with ADD2 Media Expansion	ShopIntel.com	26.00
NVIDIA GeForce 6200	Newegg.com	94.00
NVIDIA GeForce 6600	Newegg.com	118.00
NVIDIA GeForce 7800 GTX	Newegg.com	519.00
<i>DVD players</i>		
Denon DVD-2910	Denon.com <sup>(1)</sup>	699.00
Samsung DVD-HD950	Froogle.com <sup>(2)</sup>	192.99
Sony DVP-NS50P	SonyStyle.com <sup>(3)</sup>	79.95

(1) <http://www.usa.denon.com/ProductDetails/228.asp>

(2) <http://froogle.google.com/froogle?q=Samsung+DVD-HD950&btnG=Search+Froogle>

(3) [http://www.sonystyle.com/is-bin/INTERSHOP.enfinity/eCS/Store/en/-/USD/SY\\_DisplayProductInformation-Start?ProductSKU=DVPNS50P%2fS&Dept=tvvideo&CategoryName=hav\\_DVD\\_DVDPlayers](http://www.sonystyle.com/is-bin/INTERSHOP.enfinity/eCS/Store/en/-/USD/SY_DisplayProductInformation-Start?ProductSKU=DVPNS50P%2fS&Dept=tvvideo&CategoryName=hav_DVD_DVDPlayers)

**Figure 9: Pricing information for all the graphics adapters and DVD players we tested.**

## Appendix D: Windows updates we applied on the test system

This appendix lists all the Windows updates we applied on 08/31/2005.

- Critical Updates
  - Critical Update for Windows XP (KB886185)
- Security Updates
  - Security Update for Windows XP (KB896423)
  - Security Update for Windows XP (KB899587)
  - Security Update for Windows XP (KB899591)
  - Security Update for Windows XP (KB893756)
  - Security Update for Windows XP (KB899588)
  - Security Update for Windows XP (KB896358)
  - Security Update for Windows XP (KB890859)
  - Security Update for Windows XP (KB901214)
  - Security Update for Windows XP (KB893066)
  - Security Update for Windows XP (KB896428)
  - Security Update for Windows XP (KB896422)
  - Security Update for Windows XP (KB890046)
  - Security Update for Windows XP (KB885250)
  - Security Update for Windows XP (KB885835)
  - Security Update for Windows XP (KB893086)
  - Security Update for Windows XP (KB873333)
  - Security Update for Windows XP (KB888113)
  - Security Update for Windows XP (KB891781)
  - Security Update for Windows XP (KB888302)
  - Security Update for Windows XP (KB885836)
  - Security Update for Windows XP (KB873339)
- Security Updates for Windows Messenger
  - Security Update for Windows Messenger (KB887472)
- Update for Windows XP
  - Update for Windows XP (KB898461)
  - Update for Windows XP (KB894391)
  - Update for Windows XP (KB887742)
  - Update for Windows XP (KB900930)
  - Update for Windows XP (KB896344)
- Update for Windows XP Media Center Edition 2004
  - Update for Windows XP Media Center Edition 2005 (KB888316)
  - Update Rollup 1 for eHome Infrared Receiver for Windows XP Media Center Edition 2005 (KB888795)
  - Update Rollup 1 for Windows XP Media Center Edition 2005 with HDTV Support (KB873369)
- Windows Malicious Software Removal Tool
  - Windows Malicious Software Removal Tool - August 2005 (KB890830)
- Cumulative Security Update for Internet Explorer
  - Cumulative Security Update for Internet Explorer for Windows XP (KB896727)
- Cumulative Security Update for Outlook Express
  - Cumulative Update for Outlook Express for Windows XP (KB887797)
- Microsoft Windows Installer 3.1
- Update for Windows Media Connect
- Microsoft Windows Journal Viewer (Windows XP)
- Microsoft .NET Framework
  - Microsoft .NET Framework version 1.1
  - Microsoft .NET Framework 1.1 Service Pack 1

- Security Update for Microsoft .NET Framework, Version 1.1 Service Pack 1 (KB886903)
- Security Update for Microsoft .NET Framework, Version 1.0 Service Pack 3 (KB887998)
- Update for Windows XP HighMat Support in CD Writing Wizard (KB831240)
- Windows Genuine Advantage Validation Tool (KB892130)



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