Photoshop CS4 performance comparison: Solid-state drives vs. hard disk drives

Executive summary

Intel Corporation (Intel) commissioned Principled Technologies (PT) to compare the performance on visualization tasks of two types of disk drives:

- Intel X25-E Extreme SATA solid-state drives (SSDs)
- Standard 15K RPM SAS hard disk drives (HDDs)

We created a test that included four tasks in Adobe Photoshop CS4: opening the Photoshop application, opening an image, rotating the image, and saving the modified image as a PSD file.

We tested four Seagate Savvio 15K RPM SAS 73GB hard disk drives and four Intel X25-E Extreme SATA 32GB solid-state drives. We used a Newisys NDS-2240 enclosure attached to a workstation installed with the 32-bit edition of Windows Vista Ultimate with SP1 and Microsoft Office 2007 Enterprise Edition on internal drives. We installed Adobe Photoshop CS4 on the test drives.

Figure 1 shows the performance results for the HDDs and the SSDs. These results are the times for the four Photoshop tasks running both on their own (single-tasking) and while an unzip task ran in the background (multi-tasking). We report the individual task times and the total time for the four tasks. We ran the test three times and report results from the run that produced the median total time.

KEY FINDINGS

- In our single-tasking tests, four SSDs completed four typical Photoshop tasks as much as 34 percent faster than did four HDDs. (See Figure 1.)
- In our multi-tasking tests, four SSDs completed four typical tasks up to 44 percent faster than did four HDDs when we ran the tasks in the foreground while unzipping a file in the background. (See Figure 1.)
- Compared to the single-tasking tests, the multi-tasking tests took the SSDs approximately 0.6 seconds longer, a penalty of only 7 percent, while the HDDs took approximately 3.6 seconds longer, a penalty of 27 percent. (See Figure 3.)

**Photoshop results
Lower results are better**

- 4 Seagate Savvio 15K SAS HDDs (single-tasking): 13.5
- 4 Intel X25-E Extreme SATA SSDs (single-tasking): 8.9 — Up to 34% faster single-tasking
- 4 Seagate Savvio 15K SAS HDDs (multi-tasking): 17.1
- 4 Intel X25-E Extreme SATA SSDs (multi-tasking): 9.5 — Up to 44% faster multi-tasking

Time (in seconds)
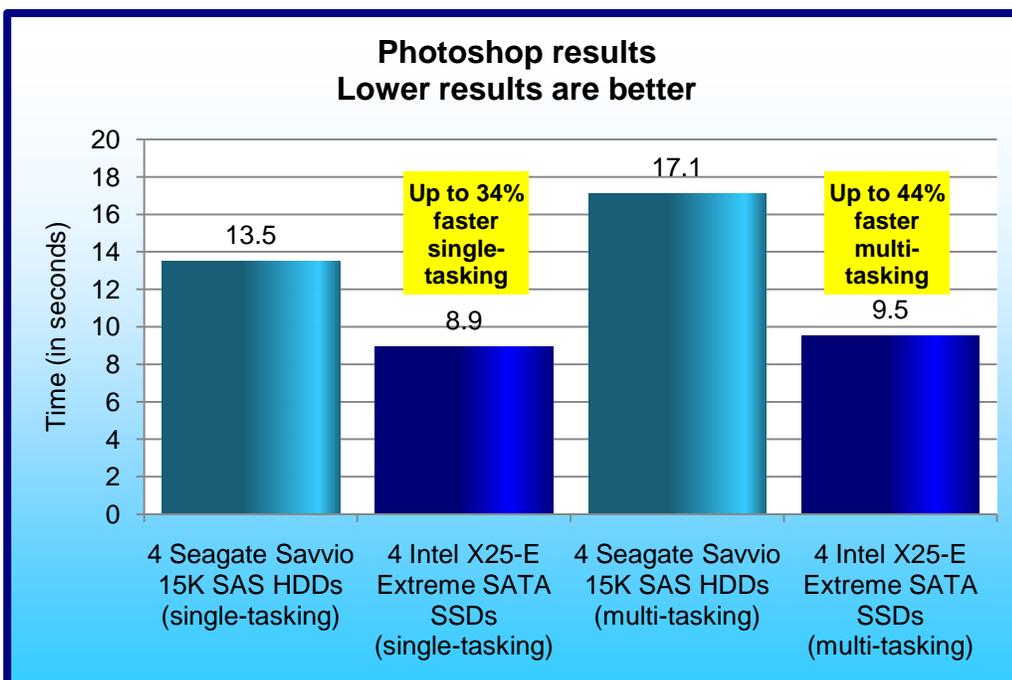
Figure 1: Photoshop performance results in task times for the two storage configurations. Lower times are better.

The four Intel X25-E Extreme SATA 32GB solid-state drives delivered up to 34 percent faster times in the single-tasking tests than did the four Seagate Savvio 15K RPM SAS 73GB hard disk drives: 8.9 seconds total time for the SSDs versus 13.5 seconds total time for the HDDs. In the multi-tasking test, the SSDs delivered as much as 44 percent faster times on the same four tasks when we ran them while we unzipped a file in the background. In that test, the four SSDs finished the tasks in approximately 9.5 seconds versus 17.1 seconds for the

HDDs. The SSDs took approximately 0.6 seconds longer to complete the multi-tasking tests, a performance penalty of only 7 percent, while the HDDs took 3.6 seconds longer to complete the multi-tasking tests, a performance penalty of 27 percent.

Workload

We installed Photoshop CS4 on the external drives, along with the following two files that we used during the test:

- 119MB Photoshop PSD test file
- 814MB ZIP self-extracting executable

The single-tasking tests included the following tasks:

1. Open and close the following programs to simulate normal usage: Microsoft Excel, Microsoft Word, Microsoft PowerPoint, Windows Media Player, and Microsoft Outlook.
2. Extract the ZIP file onto the external drives.
3. Open Photoshop.
4. Open the Photoshop test file.
5. Rotate the Photoshop image 180 degrees.
6. Save the image to a new PSD file on the external drives.

The multi-tasking tests included the following tasks:

1. Extract the ZIP file onto the external drives.
2. Open Photoshop.
3. Open the Photoshop test file.
4. Rotate the Photoshop image 180 degrees.
5. Save the image to a new PSD file on the external drives.

For the single-tasking test, we waited until the ZIP file extraction completed before opening Photoshop. For the multi-tasking test, we started the Open Photoshop task 15 seconds into the unzip task and completed the four Photoshop tasks while the unzip task ran. For both the single-tasking and multi-tasking tests, we timed the Photoshop tasks. We also timed the background task for the multi-tasking test.

Test results

Figure 2 includes the results we show in Figure 1 and the percentage wins for each task.

Photoshop task times								
	Single-tasking				Multi-tasking			
	Four Seagate Savvio 15K SAS HDDs	Four Intel X25-E Extreme SATA SSDs	Seconds win for SSDs	Percentage win for SSDs	Four Seagate Savvio 15K SAS HDDs	Four Intel X25-E Extreme SATA SSDs	Seconds win for SSDs	Percentage win for SSDs
Open Photoshop	8.72	5.01	3.71	42.5%	11.62	5.33	6.29	54.1%
Open a large file in Photoshop	2.02	1.37	0.65	32.2%	2.59	1.50	1.09	42.1%
Rotate a large file 180 degrees	1.25	1.18	0.07	5.6%	1.44	1.29	0.15	10.4%
Save a large file as a new PSD file	1.51	1.37	0.14	9.3%	1.47	1.41	0.06	4.1%
Total time	13.50	8.90	4.60	33.9%	17.10	9.50	7.60	44.3%

Figure 2: Individual task times and total task time for the four Photoshop tasks in the single- and multi-tasking tests. Results are from the run that produced the median total time. Percentage wins use the following formula: 1-(SSD result/HDD result).

The SSDs were faster on all four tasks. They delivered their biggest performance boost in the Open Photoshop task, where they were faster than the HDDs by 3.71 seconds in the single-tasking test and 6.29 seconds in the multi-tasking test.

Figure 3 shows a comparison of the times for the single-tasking and multi-tasking versions of the test. These times display the differences between the multi-tasking total time and the single-tasking total time, as well as how much longer the multi-tasking tasks took. Open Photoshop was the most demanding performance test. The HDDs took nearly 3 seconds longer in the multi-tasking tests than in the single-tasking tests. For this same comparison, the performance penalty for the SSDs was much smaller—the Open Photoshop task took just under a third of a second longer in the multi-tasking test than in the single-tasking test. Total task time for the multi-tasking test was 3.62 seconds longer than for the single-tasking test on the HDDs, a 27 percent performance hit. By contrast, the SSDs took only 0.6 seconds longer to carry out the four tasks in the multi-tasking test than in the single tasking test, a performance penalty of only 7 percent.

Multi-tasking penalty		
System	Four Seagate Savvio 15K SAS HDDs	Four Intel X25-E Extreme SATA SSDs
Open Photoshop	2.90	0.32
Open a large file in Photoshop	0.57	0.13
Rotate a large file 180 degrees	0.19	0.11
Save a large file as a new PSD file	-0.04	0.04
Total time for all four tasks	3.62	0.60
Percentage difference between total time for single- and multi-task	27%	7%

Figure 3: Additional time tasks took in multi-tasking test than in single-tasking test. Results are from the same median runs shown in Figures 1 and 2.

Appendix A gives the individual test run results.

Test methodology

Intel selected and provided the storage array, HDDs, SSDs, and workstation. Figure 4 presents the drives we tested, and Appendix B provides more detailed information on the storage configuration.

System	Seagate Savvio 15K SAS HDDs	Intel X25-E Extreme SATA SSDs
Vendor and model number	Seagate ST973451SS	Intel SSDsA2SH032G1GN
Number of drives in system	4	4
Size	73 GB	32 GB
RPM	15,000 RPM	N/A
Type	SAS 3.0 Gb/s	SATA 3.0 Gb/s
Controller	LSI Logic MegaRAID SAS 8888ELP RAID Controller	LSI Logic MegaRAID SAS 8888ELP RAID Controller
Controller driver	LSI 3.8.0.64 (08/12/2008)	LSI 3.8.0.64 (08/12/2008)

Figure 4: The drives we tested.

Figure 5 summarizes the workstation configuration, and Appendix C provides detailed configuration information for that workstation, which we do not name because it is part of the anonymous test bed and not the storage arrays under test.

Test workstation	
Processors	Two Quad-Core Intel Xeon X5460 processors at 3.16 GHz
Memory	4 GB of FB-DDR2 PC5300 memory
Internal disk	One 250GB, 7200RPM Seagate ST3250410AS SATA 3.0 Gb/s drive
NIC	Broadcom NetXtreme Gigabit Ethernet
OS	Windows Vista Ultimate 32-bit edition with SP1
Test software	Adobe Photoshop CS4; Microsoft Office 2007 Enterprise Edition

Figure 5: Test workstation configuration.

Setting up the test hardware
1. Install the LSI Logic MegaRAID SAS 8888ELP RAID controller card on the workstation.
2. Connect the Newisys NDS-2240 enclosure to the workstation via the controller card.
3. Install the four HDDs (or four SSDs) into the Newisys enclosure.

Setting up the RAID (SSDs and HDDs)
1. Enter the MegaRAID BIOS Configuration Utility.
2. Select your adapter, and click Next.
3. Click Configuration Wizard.
4. Select New Configuration, and click Next.
5. At the This is a Destructive Operation! screen, click Yes.
6. Select Custom Configuration, and click Next.
7. Assign all of the drives in your array to your RAID, and click Accept DG.
8. Click Next.
9. Click Add to SPAN.
10. Click Next.
11. When setting up the SSDs, set the RAID level to RAID 0, set Disk Cache to enabled, and change Select Size to the suggested RAID 0 size on the right for the SSDs. For the HDDs, change Select Size to the suggested RAID 0 size for the SSDs (118,252 MB) as well. Click Next.
12. Click Accept.
13. Click Yes.
14. Click Yes.
15. Click Home.
16. Click Exit.

Seasoning the drives (SSDs only)
Note: We preconditioned the drives so that our tests would deliver accurate sustained performance values. Without preconditioning, tests could deliver highly variable performance.
1. Plug in an SSD that you have securely erased or freshly performed a low-level format on.
2. Initialize the disk, and format it as NTFS.
3. With Iometer, run a one-second 128K sequential read test to the entire logical block addressing (LBA) drive space. This enables all LBAs to have some content so the SSD does not have an artificially high reserve space. Note: We used Iometer 2008-06-22-rc1, available from http://sourceforge.net/projects/iometer.
4. Delete the IOBW.tst file from the SSD drive.
5. With Iometer, run a 5,700-second 128K sequential read test (request size aligned on 4K sector boundaries) on 100 percent of the drive. This preconditions the drive.

Formatting the drive array with Diskpart (SSDs and HDDs)
1. Open a command prompt.
2. Type `cd c:\windows\system32`
3. Type `diskpart.exe`
4. Type `List Disk` to determine the name of your RAID array.

5. Type `Select Disk #` where Disk # is the name of your RAID array.
6. Type `Create partition primary align=4`
7. Type `Assign Letter=E` to assign this new partition the letter E.
8. Type `Exit`
9. In Windows, click Start, right-click My Computer, and select Manage.
10. Click Disk Management.
11. Right-click the partition, and select Format.
12. Name the partition according to what kind of drives you are using, and format the drives as NTFS.

Installing Windows Vista Ultimate 32-bit edition with SP1 on the internal workstation drive

1. Boot to Windows Vista Ultimate with SP 1 DVD.
2. When the installer prompts you to press any key to boot from CD or DVD, press any key. It may take several minutes for Windows setup to load.
3. At the Language, time, and keyboard preference screen, accept the default options, and click Next.
4. Click Install now.
5. Enter the product key, and click Next.
6. Check I accept the license terms, and click Next.
7. At the type of installation screen, select Custom (advanced).
8. Click Drive options (advanced).
9. Select the destination disk for the operating system.
10. Click Format.
11. At the All data stored will be permanently deleted dialog, click OK.
12. Once the system finishes formatting the disk, click Next.
13. Windows begins the install process and automatically reboots the system twice.
14. After the second reboot, fill in the Username, password, and password hint fields.
15. Select a picture for the user account, and click Next.
16. Fill in the computer name field, choose a desktop background, and click Next.
17. When the option to enable Automatic Updates appears, click Ask me later.
18. Select the correct time zone, date, and time; and click Next.
19. At the Thank you screen, click Start.
20. When the Windows Vista Ultimate with Service Pack 1 installation completes, log into Windows, and close the Welcome Center Dialog.

Installing Adobe Photoshop CS4 on the external drives in the enclosure

1. Double-click setup.exe.
2. Click I want to Install and use Adobe Photoshop CS4 on a trial basis, and click next.
3. At the Adobe Photoshop CS4 Install-License screen, click Accept.
4. Click Change… under Installation Location, and set the Installation Location to E:\Photoshop.
5. Click Install.
6. After installation completes, click Exit.

Copying the test files onto the test drives

1. Copy the 119MB Photoshop PSD test file onto the E: drive.
2. Copy the 814MB ZIP self-extracting executable onto the E: drive.

Installing Microsoft Office 2007 Enterprise Edition on the internal drive using the default installation

1. Insert the Microsoft Office Enterprise 2007 DVD.
2. At the AutoPlay dialog box, click Run setup.exe.
3. After setup loads, click Install Now.
4. After installation completes, click Close.

Running the test

We followed the steps in this section to run the single-tasking and multi-tasking tests on the SSDs and HDDs.

As part of the test procedure, we deleted the contents of the C:\Windows\Prefetch folder before each run. This creates a more consistent test as it resets the Windows Superfetch cache. We also simulated normal use by opening and closing several applications before starting the timed tasks for the single-tasking tests.

Single-tasking version
1. Restart the workstation.
2. After the system has booted up, start a stopwatch timer.
3. Open the C:\Windows\Prefetch Folder, and delete the contents.
4. When the timer reaches 2 minutes, open and close the following programs to simulate normal usage: Microsoft Excel, Microsoft Word, Microsoft PowerPoint, Windows Media Player, and Microsoft Outlook.
5. Prepare to extract the ZIP file by double-clicking the extracting EXE.
6. Set the ZIP file to extract to the external drives.
7. Extract the large ZIP file onto the external drives.
8. After the unzipping process completes, open Photoshop. Time how long it takes Photoshop to open to a blank screen.
9. When Photoshop finishes opening, click File->Open, open the Photoshop PSD test file, and time how long it takes the image to fully appear on the screen.
10. Rotate the image 180 degrees by clicking Image->Image Rotation->180. Time how long it takes the image to rotate.
11. Save the image as a new PSD on the external drives by clicking File->Save as.
12. Name the file `test1`, `test2`, or `test3`, depending on the run number.
13. At the Photoshop Format Options window, click OK, and time how long it takes to save the image.
14. Close Photoshop.
15. Repeat steps 1 through 14, for a total of three test runs.

Multi-tasking version
1. Restart the workstation.
2. After the system has booted up, start timing.
3. Open the C:\Windows\Prefetch Folder, and delete the contents.
4. Prepare to extract the ZIP file by double-clicking the extracting EXE.
5. Set the ZIP file to extract to the external drives.
6. When the timer reaches 2 minutes, start a second timer, and begin extracting the large ZIP file onto the external drives.
7. When the second timer reaches 15 seconds, open Photoshop. Time how long it takes Photoshop to open to a blank screen.
8. When Photoshop finishes opening, click File->Open, open the Photoshop PSD test file, and time how long it takes the image to fully appear on the screen.
9. Rotate the image 180 degrees by clicking Image->Image Rotation->180. Time how long it takes the image to rotate.
10. Save the image as a new PSD on the external drives by clicking File->Save as.
11. Name the file `test1`, `test2`, or `test3`, depending on the run number.
12. At the Photoshop Format Options window, click OK, and time how long it takes to save the image.
13. Close Photoshop.
14. Wait for the unzipping process to complete, and stop your second timer.
15. Repeat steps 1 through 14, for a total of three test runs.

Appendix A: Test results

Figure 6 lists test results for the three runs of the single-tasking and multi-tasking versions of the test on the two test configurations.

Single-tasking			
Run 1	**Four Seagate Savvio 15K SAS HDDs**	**Four Intel X25-E Extreme SATA SSDs**	**Percentage win for SSDs**
Open Photoshop	8.66	4.81	44.50%
Open a large file in Photoshop	1.83	1.40	23.50%
Rotate a large image 180 degrees	1.32	1.24	6.10%
Save a large file as a new PSD file	1.49	1.38	7.40%
Total time	13.30	8.83	33.60%
Run 2	**Four Seagate Savvio 15K SAS HDDs**	**Four Intel X25-E Extreme SATA SSDs**	**Percentage win for SSDs**
Open Photoshop	8.72	5.01	42.50%
Open a large file in Photoshop	2.02	1.37	32.20%
Rotate a large image 180 degrees	1.25	1.18	5.60%
Save a large file as a new PSD file	1.51	1.37	9.90%
Total time	13.50	8.93	33.90%
Run 3	**Four Seagate Savvio 15K SAS HDDs**	**Four Intel X25-E Extreme SATA SSDs**	**Percentage win for SSDs**
Open Photoshop	8.96	4.87	45.60%
Open a large file in Photoshop	1.82	1.63	10.40%
Rotate a large image 180 degrees	1.36	1.30	4.40%
Save a large file as a new PSD file	1.50	1.43	4.70%
Total time	13.64	9.23	32.30%
Multi-tasking			
Run 1	**Four Seagate Savvio 15K SAS HDDs**	**Four Intel X25-E Extreme SATA SSDs**	**Percentage win for SSDs**
Open Photoshop	10.63	5.33	49.90%
Open a large file in Photoshop	2.91	1.50	48.50%
Rotate a large image 180 degrees	1.53	1.29	15.70%
Save a large file as a new PSD file	1.46	1.41	3.40%
Total time for Photoshop tasks	16.53	9.53	42.30%
Concurrent unzip of other large file	148.91	122.75	17.60%
Run 2	**Four Seagate Savvio 15K SAS HDDs**	**Four Intel X25-E Extreme SATA SSDs**	**Percentage win for SSDs**
Open Photoshop	11.62	5.47	52.90%
Open a large file in Photoshop	2.59	1.36	47.50%
Rotate a large image 180 degrees	1.44	1.19	17.40%
Save a large file as a new PSD file	1.47	1.28	12.90%
Total time for Photoshop tasks	17.12	9.30	45.70%
Concurrent unzip of other large file	148.89	121.88	18.10%

Multi-tasking			
Run 3	**Four Seagate Savvio 15K SAS HDDs**	**Four Intel X25-E Extreme SATA SSDs**	**Percentage win for SSDs**
Open Photoshop	11.15	5.67	49.10%
Open a large file in Photoshop	3.00	1.76	41.30%
Rotate a large image 180 degrees	1.71	1.19	30.40%
Save a large file as a new PSD file	1.45	1.39	4.10%
Total time for Photoshop tasks	17.31	10.01	42.20%
Concurrent unzip of other large file	150.84	123.96	17.80%

Figure 6: Results for the single-tasking and multi-tasking tests. We calculate percentage wins with the following formula: 1-SSD result/HDD result.

Appendix B: Storage configuration

Figure 7 shows the storage hardware.

System	Four Seagate Savvio 15K SAS HDDs	Four Intel X25-E Extreme SATA SSDs
Storage connectivity (fibre channel, SAS, SATA, iSCSI)	SAS	SATA
Storage model and OS/firmware revision	Newisys NDS-2240	Newisys NDS-2240
Number of storage controllers	1	1
HBA model and firmware	MegaRAID SAS 8888ELP 1.40.02-0514	MegaRAID SAS 8888ELP 1.40.02-0514
Number of HBAs/host	1	1
Total number of drives we tested in solution	4	4

Figure 7: Primary storage hardware.

Figure 8 shows the storage drive configuration.

System	Four Seagate Savvio 15K SAS HDDs	Four Intel X25-E Extreme SATA SSDs
Drive type, speed	SAS, 15K RPM	SSD
Firmware	SM04	8620
Raw capacity per drive	73 GB	32 GB
Number of physical drives in test	4	4
Total raw storage capacity	292	128
RAID level	RAID 0	RAID 0
Total formatted capacity	118,252 MB*	118,252 MB

Figure 8: Primary storage drive configuration.

*Before we formatted the HDDs, we short-stroked the drives to have the same amount of space as four SSDs in a RAID 0.

Appendix C: Test environment

Figure 9 describes the test workstation.

Test workstation	
General	
Number of processor packages	2
Number of cores per processor package	4
Number of hardware threads per core	4
System Power Management Policy	Balanced
CPU	
Vendor	Intel
Name	Xeon X5460
Stepping	6
Socket type	Socket 771-LGA
Core frequency (GHz)	3.16
Front-side bus frequency (MHz)	1,333
L1 cache	32 KB + 32 KB (per core)
L2 cache	12 MB (2 x 6 MB shared)
Platform	
Motherboard model number	HP 0A98h
Motherboard chipset	Intel 5400B
Motherboard revision number	C0
BIOS name and version	Hewlett-Packard 786F5 v01.27 (08/08/2008)
BIOS settings	Default
Chipset INF driver	Intel 8.5.0.1009
Memory module(s)	
Vendor and model number	ELPIDA EBE21FD4AJFT-6E-E
Type	FB-DDR2 PC-5300
Speed (MHz)	667
Speed in the system currently running @ (MHz)	667
Timing/latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15
Size (MB)	4,096
Number of RAM modules	2 x 2,048 MB
Chip organization	Double-sided
Channel	Dual
Hard disk	
Vendor and model number	Seagate ST3250410AS
Number of disks in system	1
Size (GB)	250
Buffer size (MB)	16
RPM	7,200
Type	SATA 3.0 Gb/s
Controller	Intel 6321ESB
Controller driver	Intel 8.2.0.1011 (10/15/2006)

Test workstation	
Operating system	
Name	Windows Vista Ultimate 32-bit edition
Build number	6001
Service Pack	SP1
File system	NTFS
Language	English
Microsoft DirectX version	9.0c
Graphics	
Vendor and model number	NVidia Quadro FX3700
Chipset	NVidia Quadro
BIOS Version	62.92.27.00.13
Type	PCI-E
Memory size (MB)	512
Resolution	1,024 x 768 x 32-bit
Driver	Microsoft 6.0.6001.18000 (6/21/2006)
Network card/subsystem	
Vendor and model number	Broadcom NetXtreme Gigabit Ethernet
Type	Integrated
Driver	10.100.0.0 (7/25/2008)
Optical drive	
Vendor and model number	HL-DT-ST DVD-RAM GH15L
Type	CD/DVD-ROM
Interface	SATA
Dual/single layer	Dual
USB ports	
Number of ports	7
Type of ports (USB 1.1, USB 2.0)	2.0

Figure 9: Detailed system configuration information for the test workstation.

About Principled Technologies

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We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help you assess how it will fare against its competition, its performance, whether it's ready to go to market, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.