Principled Technologies®

Notebook system processors: Performance increase from upgrading to current Intel Core i5 Processor-based systems

Test report commissioned by Intel Corp. July 2010

Executive summary

Businesses upgrade their employees' notebook systems to maximize productivity. In Principled Technologies' tests in our labs, two current Intel® Core™ i5 Processor-based notebook systems delivered better performance than a current-generation, triple-core, AMD Turion™ II Ultra-based system and two previous generation Intel processor-based systems on a range of tests. Because better system performance—executing tasks more quickly—translates to increased user productivity, our results show that companies can significantly benefit from upgrading to an Intel Core i5-430M Processor-based system or an Intel Core i5-520M Processor-based system.

To gauge how well each notebook system would perform for typical business users, we used the SYSmark® 2007 Preview v1.06 (SYSmark) benchmark. We also used the following application-based tests, which Intel selected to represent realistic notebook system usage:

KEY FINDINGS

- The Intel Core i5-430M and 520M Processor-based systems performed better across all tests than the AMD Turion II Ultra-based system: up to 76.4% better SYSmark performance, up to 136.4% faster Excel and WinZip multitasking performance, and up to 90.9% faster Excel Big Number Crunch performance. (See Figure 1.)

- The Intel Core i5-430M and 520M Processor-based systems performed better across all tests than the Intel Core 2 Duo P8700-based system: up to 18.0% better SYSmark performance, up to 47.3% faster Excel and WinZip multitasking performance, and up to 36.4% faster Excel Big Number Crunch performance. (See Figure 2.)

- The Intel Core i5-430M and 520M Processor-based systems performed better across all tests than the Intel Core 2 Duo T6670-based system: up to 34.2% better SYSmark performance, up to 60.0% faster Excel and WinZip multitasking performance, and up to 109.1% faster Excel Big Number Crunch performance. (See Figure 3.)

- Multitasking test in Microsoft® Office® Excel® 2007 (Excel) using Monte Carlo Black-Scholes, and WinZip® 14
- Big number crunch in Microsoft Office Excel 2007 using the Big Number Crunch XLSM file

In all three tests, the two current Intel Core i5 Processor-based notebook systems significantly outperformed the current-generation, triple-core, AMD Turion II Ultra-based system and the previous-generation Intel Core 2 Duo P8700-based system and Intel Core 2 Duo T6670-based system.
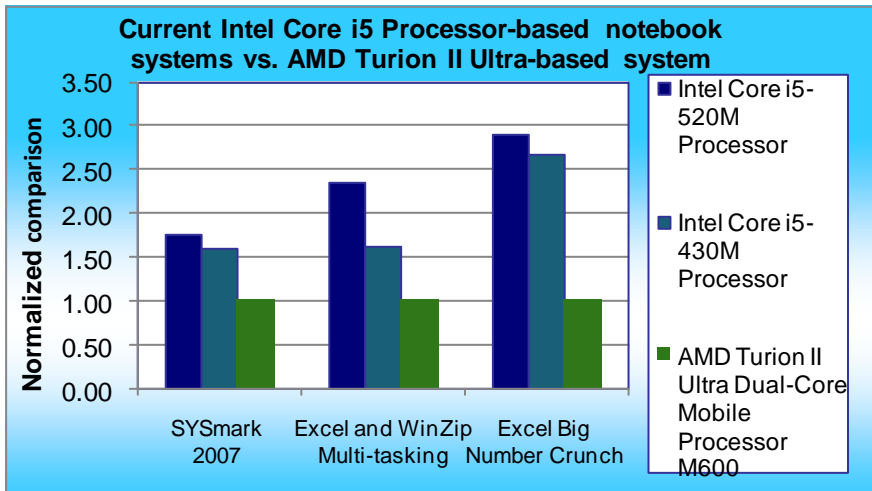
Figure 1 displays normalized test results, which show the Intel Core i5-430M and 520M Processor-based system performance increases over the AMD Turion II Ultra-based system: up to 76.4% better SYSmark performance, up to 136.4% faster Excel and WinZip multitasking performance, and up to 90.9% faster Excel Big Number Crunch performance.

Figure 1: Normalized test results for the Intel Core i5 Processor-based systems and the AMD Turion II Ultra-based system. Higher numbers are better.

Figure 2: Normalized test results for the Intel Core i5 Processor-based systems and the Intel Core 2 Duo Processor P8700-based system. Higher numbers are better.

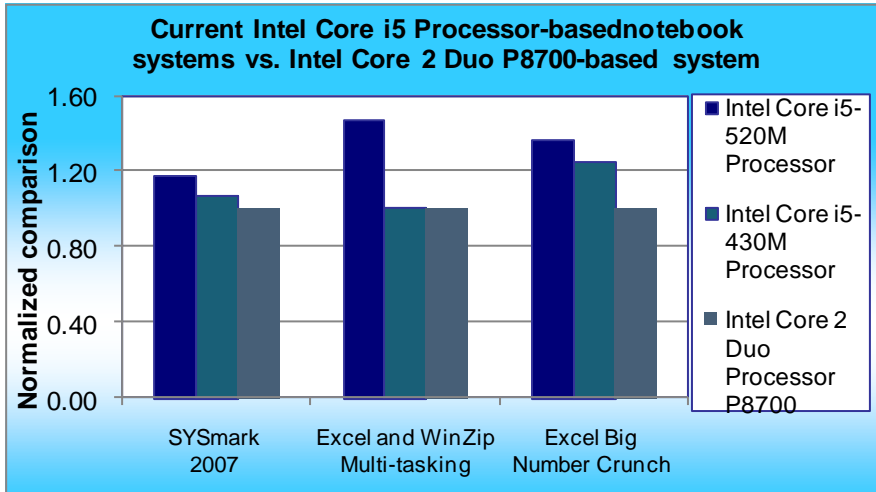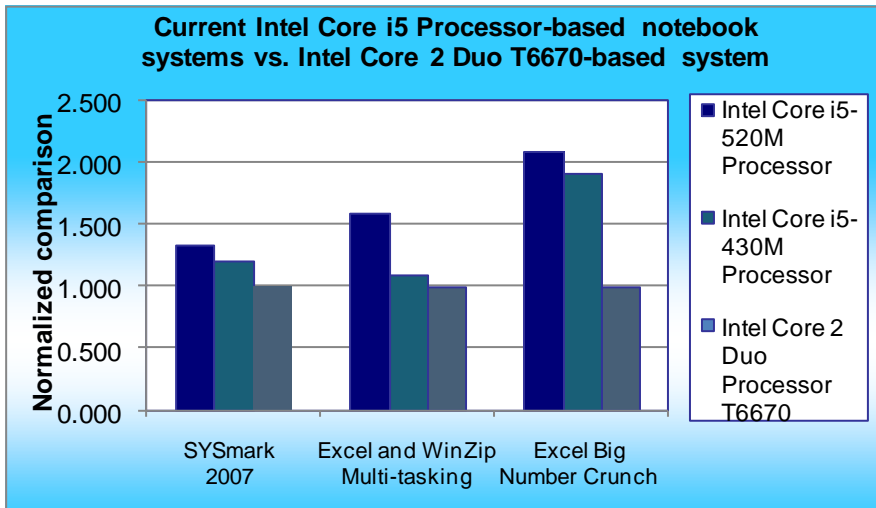**Figure 3: Normalized test results for the Intel Core i5 Processor-based systems and the Intel Core 2 Duo Processor T6670-based system. Higher numbers are better.**

Figure 2 displays normalized test results, which show the Intel Core i5-430M and 520M Processor-based system performance increases over the Intel Core 2 Duo Processor P8700-based system: up to 18.0% better SYSmark performance, up to 47.3% faster Excel and WinZip multitasking performance, and up to 36.4% faster Excel Big Number Crunch performance.

Figure 3 displays normalized test results, which show the Intel Core i5-430M and 520M Processor-based system performance increases over the Intel Core 2 Duo Processor T6670-based system: up to 34.2% better SYSmark performance, up to 60.0% faster Excel and WinZip multitasking performance, and up to 109.1% faster Excel Big Number Crunch performance.

In the following sections, we present the results of our tests (Test results), look more closely at our benchmark and application-based tests, and give detailed information about how we actually performed the tests (Test methodology). In Appendix A, we present the configurations of the test systems.

Test results

Figure 4 shows the SYSmark rating and the median time, in seconds, each notebook system took to complete each of the two custom application-based tests. We conducted each test five times and report the median time for each system. A higher SYSmark rating is better, while lower Excel application test times are better.

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Notebook systems	Benchmark and application-based tests		
	SYSmark 2007 Preview v1.06 Rating	Microsoft Office 2007 Excel Monte Carlo & WinZip 14 multi-tasking (minutes:seconds)	Microsoft Office 2007 Excel Big Number Crunch (seconds)
Intel Core i5-520M-based notebook	157	00:55	11
Intel Core i5-430M-based notebook	142	01:20	12
AMD Turion II Ultra-based notebook	89	02:10	32
Intel Core 2 Duo P8700-based notebook	133	01:21	15
Intel Core 2 Duo T6670-based notebook	117	01:28	23

Figure 4: Benchmark and application-based test results for the notebook systems. A higher SYSmark rating is better, while lower Excel application test times are better.

Benchmark and application-based tests

We selected the SYSmark benchmark, while Intel provided the two application-based tests, the results of which illustrate the benefits of a switching to a notebook system with an upgraded processor.

Each of these tests involves one or more basic operations, such as copying a folder or opening files. The results of the test are the response times for each of these operations. We used realistic operations and content for all tests.

Performance measurement using BAPCo SYSmark 2007 Preview v1.06 benchmark

We used BAPCo's SYSmark 2007 Preview v1.06 to test processor performance in four office workloads: e-learning, office productivity, video creation, and 3D modeling. SYSmark 2007 determines its overall rating from the mean result of the workloads, recording the time the system takes to complete each individual operation for each workload.

SYSmark 2007 Preview consists of the following applications and corresponding tasks: Adobe® After Effects® 7 (e-learning), Adobe Illustrator® CS2 (video creation), Adobe Photoshop® CS2 (video creation), AutoDesk® 3ds Max® 8 (3D modeling), Macromedia® Flash 8 (e-learning), Microsoft Excel 2003 (office productivity), Microsoft Outlook® 2003 (office productivity), Microsoft PowerPoint® 2003 (office productivity), Microsoft Word 2003 (office productivity), Microsoft Project 2003 (office productivity), Microsoft Windows Media™ Encoder 9 series (video creation), Sony® Vegas 7 (video creation), SketchUp 5 (3D modeling), and WinZip 10.0 (office productivity).

To learn more about the SYSmark benchmark, visit
http://www.bapco.com/support/sysmark2007preview/Help/Help.html.

Multitasking test in Microsoft Office Excel 2007 using Monte Carlo Black-Scholes and WinZip 14

For our multitasking test, we used the Monte Carlo Black-Scholes mathematical simulation running in Microsoft Office Excel 2007 while WinZip 14 decompresses an encrypted archive of 75 JPEG images. 300,000 instances of the Monte Carlo-Black Sholes mathematical simulation run in Excel, where they calculate hypothetical call and put prices, and use Excel's lookup functions to compare these prices against historical market prices.

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Big Number Crunch test in Microsoft Office Excel 2007 using the Big Number Crunch XLSM file

We used the Excel Big Number Crunch workload to test processor performance while Excel performs common calculations like addition, subtraction, division, rounding, and square root. This workload runs approximately 28,000 sets of calculations. We determine processor performance by the task time Excel took to complete the Big Number Crunch workload.

Test methodology

We provide the methodology for two groups of tests: industry-standard benchmark tests (SYSmark 2007), and application-based tests (Microsoft Office Excel 2007 Monte Carlo Black-Scholes + WinZip 14 multitasking test and Microsoft Office Excel 2007 Big Number Crunch). We captured ghost images of factory OEM images as they arrived and used these images as the base for all systems in this study.

Using the base test image

With the exception of SYSmark 2007, which required us to remove conflicting applications, we conducted all testing on the original factory image. We used Symantec's Ghost solution to reset the system to the factory OEM image before we ran each test.

Industry-standard benchmarks
BAPCo SYSmark 2007 Preview v1.06

Setting up SYSmark 2007
1. Reset the system to the base test image.
2. Disable the User Account Control:
    a. Click Start→Control Panel.
    b. At the User Accounts and Family Safety settings screen, click Add or remove user account.
    c. At the User Account Control screen, click Continue.
    d. Click Go to the main User Accounts page.
    e. At the Make changes to your user account screen, click Turn User Account Control on or off.
    f. At the User Account Control screen, click Continue.
    g. Uncheck Use User Account Control to help protect your computer, and click OK.
    h. At the You must restart your computer to apply these changes screen, click Restart Now.
3. Purchase and install SYSmark 2007 Preview v1.06 from https://www.bapcostore.com/store/product.php?productid=16165&cat=251&page=1.
4. At the Welcome to InstallShield Wizard screen, click Next.
5. At the License Agreement screen, select I accept the terms in the License Agreement, and click Next.
6. At the Choose Destination Location screen, click Next.
7. At the Ready to Install the Program screen, click Install.
8. When the installation is complete, click Finish.
9. Run the BAPCo auto-configuration tool v1.3.2:
    a. Click the BAPCo auto-configuration batch file.
    b. Choose S to select SYSmark 2007.
    c. Choose option 3 in order to produce the most consistent scores.
10. Reboot the system.

Running the SYSmark 2007
1. Launch SYSmark 2007 Preview by double-clicking the desktop icon.
2. Click Run.
3. Select Official Run, choose 3 Iterations, check the box beside Run conditioning run, and enter a name for that run.
4. When the benchmark completes and the main SYSmark 2007 Preview menu appears, click Save FDR to create a report.
5. Record the results.

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Application-based tests
Microsoft Office Excel 2007 Monte Carlo Black-Scholes + WinZip 14 multitasking test
Intel provided the following files that this test uses:

- MonteCarloBlackScholesOptionPricing.xlsm. The file size is 70.1 MB (73,607,121 bytes)
- 75.zip. The file size is 375 MB (393,691,136 bytes)

We performed the following steps to set up and run this test:

Setting up the Excel and WinZip multitasking test
1. Reset the system to the base test image.
2. Copy the MonteCarloBlackScholesOptionPricing.xlsm test file to the Documents directory.
3. Copy the 75.zip test file to the Documents directory.
4. Install Microsoft Office 2007 Ultimate Edition with default settings:
    a. At the Enter your Product Key screen, enter the product key, and click Continue.
    b. At the License Agreement screen, select I accept the terms of this agreement, and click Continue.
    c. At the Microsoft Office Ultimate 2007 has been successfully installed screen, click Close.
5. Launch Microsoft Office Excel 2007 by clicking Start→All Programs→Microsoft Office→Microsoft Office Excel 2007.
6. Select I want to activate the software over the Internet, and click Next.
7. Click Finish.
8. Uncheck Search Microsoft Office Online for Help content when I'm connected to the Internet, and click Next.
9. Select I don't want to use Microsoft Update, and click Finish.
10. Click the Microsoft Office button located in the top left.
11. Click Excel Options.
12. Click Trust Center, located in the left column.
13. Click the Trust Center Settings button.
14. Click Macro Settings located in the left column, and select Enable all macros.
15. Click OK.
16. Close Excel.
17. Purchase WinZip 14 from http://www.winzip.com/index.htm.
18. Install WinZip 14 with default settings.
19. Double-click the WinZip icon on your desktop to launch WinZip.
20. Enter the registration information, and click Register.
21. Select Never show tips at startup from the WinZip Tip of the Day dialog box, and click Close.
22. Close WinZip 14.
23. Reboot the system.
24. Run disk defragmenter by clicking Start→All Programs→Accessories→System Tools→Disk Defragmenter.
25. Delete the contents of C:\Windows\Prefetch.

Running the Excel and WinZip multitasking test
1. Launch Microsoft Office Excel 2007 by clicking Start→All Programs→Microsoft Office→Microsoft Office Excel 2007.
2. Press Ctrl+O.
3. Locate the MonteCarloBlackScholesOptionPricing.xlsm workload file, and click Open.
4. Double-click the WinZip icon on your desktop to launch WinZip.
5. Click the Open button to open an archive.
6. Navigate to the directory where the archive is located, and select the archive by pressing Enter.
7. Leave the password field blank, and click Cancel.
8. Select all the contents of the archive, and click Extract to extract the contents.
9. Select Documents as the target location for extraction, and click Extract.
10. When the application prompts you to do so, enter the password.
11. Type `rundll32.exe advapi32.dll,ProcessIdleTasks` in the Start Search command prompt.

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12. Type `perfmon` in the Start Search command prompt.
13. Expand and watch the Disk Monitor. When there are no more disk requests, close Perfmon.
14. Bring Excel to the foreground, and press Ctrl+R to begin the Excel recalculation.
15. Press Alt+Tab to bring WinZip to the foreground.
16. Simultaneously start the stopwatch and press OK.
17. Stop the stopwatch when the progress bar dialog box closes.
18. Record this as the time to complete the decompression of the WinZip archive.
19. When the Excel recalculation completes, a dialog reports the execution time of the test.
    Record this as the time it takes to complete the recalculation, and click OK to close Excel.
20. Repeat steps 1 through 19 four more times without rebooting between runs.

Microsoft Office Excel 2007 Big Number Crunch

Intel provided the file this test uses: BigNumberCrunch.xlsm. The file size is 6.24 MB (6,543,413 bytes).

We performed the following steps to set up and run this test:

Setting up Excel 2007 Big Number Crunch
1. Reset the system to the base test image.
2. Copy the BigNumberCrunch.xlsm test file to the My Documents directory.
3. Install Microsoft Office 2007 Ultimate Edition with default settings:
    a. At the Enter your Product Key screen, enter the product key, and click Continue.
    b. At the License Agreement screen, select I accept the terms of this agreement, and click Continue.
    c. At the Microsoft Office Ultimate 2007 has been successfully installed screen, click Close.
4. Launch Microsoft Office Excel 2007 by clicking Start→All Programs→Microsoft Office→Microsoft Office Excel 2007.
5. Uncheck Search Microsoft Office Online for Help content when I'm connected to the Internet, and click Next.
6. Select I don't want to use Microsoft Update, and click Finish.
7. Click the Microsoft Office button located in the top left.
8. Click Excel Options.
9. Click Trust Center located in the left column.
10. Click the Trust Center Settings button.
11. Click Macro Settings located in the left column, and select Enable all macros.
12. Click OK.
13. Close Excel.
14. Reboot the system.
15. Run disk defragmenter by clicking Start→All Programs→Accessories→System Tools→Disk Defragmenter.
16. Delete the contents of C:\Windows\Prefetch.

Running Excel 2007 Big Number Crunch
1. Launch Microsoft Office Excel 2007 by clicking Start→All Programs→Microsoft Office→Microsoft Office Excel 2007.
2. Press Ctrl+O.
3. Locate the BigNumberCrunch.xlsm workload file, and click Open.
4. Type `rundll32.exe advapi32.dll,ProcessIdleTasks` in the Start Search command prompt.
5. Type `perfmon` in the Start Search command prompt.
6. Expand and watch the Disk Monitor. When there are no more disk requests, close Perfmon.
7. Press Ctrl+R on the keyboard to start the test.
8. Record the results, and click OK.
9. Close Excel. Click No to saving results made to file.
10. Repeat steps 1 through 9 four more times without rebooting between runs.

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Appendix A – Test system information

Figure 5 provides detailed configuration for the notebook systems we tested.

System	Intel Core i5-520M-based notebook	Intel Core i5-430M-based notebook	AMD Turion II Ultra-based notebook	Intel Core 2 Duo P8700-based notebook	Intel Core 2 Duo T6670-based notebook
General					
Make and model	HP EliteBook 8440p	HP ProBook 6440b	HP ProBook 6445b	HP EliteBook 6930p	HP ProBook 4510s
Processor and OS kernel: (physical, core, logical) / (UP, MP)	1P2C4L/MP	1P2C4L/MP	1P2C2L/MP	1P2C2L/MP	1P2C2L/MP
Number of physical processors	1	1	1	1	1
Single/Dual-core processors	Dual	Dual	Dual	Dual	Dual
System power management policy	HP Optimized	HP Optimized	HP Optimized	HP Optimized	HP Optimized
Processor power-saving option	Enhanced Intel SpeedStep Technology	Enhanced Intel SpeedStep Technology	Enhanced AMD PowerNow! Technology	Enhanced Intel SpeedStep Technology	Enhanced Intel SpeedStep Technology
System dimensions (length x width x height)	13.21 x 9.3 x 1.23 in	1.33 in x 13.35 in x 9.3 in	13.35 x 9.3 x 1.33 in	9.57 x 13.0 x 1.23 in	9.83 x 14.6 x 1.24 in
System weight (lb)	5.02	5.31	5.81	5.24	5.78
CPU					
Vendor	Intel	Intel	AMD	Intel	Intel
Name	Core i5	Core i5	AMD Turion II Ultra Dual-Core Mobile	Core 2 Duo	Core 2 Duo
Model number	520M	430M	M600	P8700	T6670
Stepping	C2	C2	C2	R0	R0
Socket type and number of pins	Socket P (487)	Socket P (487)	Socket S1 (638)	Socket P (487)	Socket P (487)
Core frequency (GHz)	2.40	2.26	2.40	2.53	2.20
Front-side bus frequency	2.5 GT/s	2.5 GT/s	Hyper Transport 3,600 MHz	1,066 MHz	800 MHz
L1 cache	2 x 32 KB + 2 x 32 KB	2 x 32 KB + 2 x 32 KB	2 x 64 KB + 2 x 64 KB	2 x 32 KB + 2 x 32 KB	2 x 32 KB + 2 x 32 KB
L2 cache (MB)	3	3	2	3	2
Platform					
Vendor	Hewlett-Packard	Hewlett-Packard	Hewlett-Packard	Hewlett-Packard	Hewlett-Packard
Motherboard model number	172A	1722	307E	3072	30DB
Motherboard chipset	Intel QM57	Intel HM57	AMD M880G	Intel GM45	Intel GM45
Motherboard revision number	12	12	00	07	07

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System	Intel Core i5-520M-based notebook	Intel Core i5-430M-based notebook	AMD Turion II Ultra-based notebook	Intel Core 2 Duo P8700-based notebook	Intel Core 2 Duo T6670-based notebook
System/motherboard serial number	CND0140VBP	CND0132TW1	CND0141N41	2CE0101H5G	CNU0106HVS
BIOS name and version	Hewlett-Packard 68CCU Ver. F.06 (03/22/2010)	Hewlett-Packard 68CDD Ver. F.04 (01/27/2010)	Hewlett-Packard 68CTT Ver. F.05 (01/28/2010)	Hewlett-Packard 68PCU Ver. F.17 (03/05/2010)	Hewlett-Packard 68ZI Ver. F.14 (12/30/2009)
BIOS settings	Default	Default	Default	Default	Default
Memory module(s)					
Vendor and model number	Samsung M471B5673EH 1-CH9	ELPIDA EBE21UE8AES A-8G-F	Samsung M471B5673EH 1	Samsung M4 70T5663QZ3-CF7	Kingston HP594908-HR1-ELD
Type	DDR3 PC3-10600	DDR2 PC2-6400	DDR3 PC3-10600	DDR2 PC2-6400	DDR3 PC3 -10600
Speed (MHz)	1,333	800	1,333	800	1,333
Speed running in the system (MHz)	1,066	667	1,066	667	1,066
Timing/Latency (tCL-tRCD-tRP-tRASmin)	6-6-6-18	6-6-6-18	6-6-6-18	6-6-6-18	7-7-7-20
Size	2,048	2,048	2,048	2,048	2,048
Number of memory module(s)	1 x 2GB	1 x 2GB	1 x 2GB	1 x 2GB	1 x 2GB
Chip organization (Single-sided, Double-sided)	Double-sided	Double-sided	Double-sided	Double-sided	Double-sided
Channel (Single/Dual)	Single	Single	Single	Single	Single
Hard disk					
Vendor and model number	Seagate ST9250410AS	Seagate ST9250410AS	TOSHIBA MK2556GSY	Western Digital WD2500BEKT-60V5T1	Seagate ST9250410AS
Size (GB)	250	250	250	250	250
Buffer size (MB)	16	16	16	16	16
RPM	7,200	7,200	7,200	7,200	7,200
Type	SATA 3.0 Gb/s	SATA 3.0 Gb/s	SATA 3.0 Gb/s	SATA 3.0 Gb/s	SATA 3.0 Gb/s
Controller	Intel ICH9M-E/M SATA AHCI Controller	Intel ICH9M-E/M SATA AHCI Controller	Standard AHCI 1.0 Serial ATA Controller	Intel ICH9M-E/M SATA AHCI Controller	Intel ICH9M-E/M SATA AHCI Controller
Driver	Intel 8.9.2.1002 (07/08/2009)	Intel 8.9.2.1002 (07/08/2009)	Microsoft 6.1.7600.16385 (6/21/2006)	Intel 8.9.0.1023 (06/04/2009)	Intel 8.9.2.1002 (07/08/2009)
Operating system					
Name	Microsoft Windows 7 Professional	Microsoft Windows 7 Professional	Microsoft Windows 7 Professional	Microsoft Windows 7 Professional	Microsoft Windows 7 Professional
Build number	7600	7600	7600	7600	7600
File system	NTFS	NTFS	NTFS	NTFS	NTFS
Kernel	ACPI-x86 based PC	ACPI-x86 based PC	ACPI-x86 based PC	ACPI-x86 based PC	ACPI-x86 based PC

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System	Intel Core i5-520M-based notebook	Intel Core i5-430M-based notebook	AMD Turion II Ultra-based notebook	Intel Core 2 Duo P8700-based notebook	Intel Core 2 Duo T6670-based notebook
Language	English	English	English	English	English
Microsoft DirectX version	11	11	11	11	11
Graphics					
Vendor and model number	Mobile Intel GMA 4500MHD	Mobile Intel GMA 4500MHD	ATI Mobility Radeon HD 4200	Mobile Intel GMA 4500MHD	Mobile Intel GMA 4500MHD
Type	Integrated	Integrated	Integrated	Integrated	Integrated
Chipset	Mobile Intel 4 Series Express Chipset	Mobile Intel 4 Series Express Chipset	ATI display adapter	Mobile Intel 4 Series Express Chipset	Mobile Intel 4 Series Express Chipset
BIOS version	1994.0	1928.0	010.94.001.031.034178	1659.0	1706.0
Total available graphics memory	796	796	1,024	796	796
Dedicated video memory	64	64	64	64	64
System video memory	0	0	0	0	0
Shared system memory	732	732	946	732	732
Resolution	1,366 x 768	1,366 x 768	1,366 x 768	1,440 x 900	1,366 x 768
Driver	Intel 8.15.10.1995 (11/06/2009)	Intel 8.15.10.1995 (11/06/2009)	ATI Technologies Inc. 8.634.1.2000 (09/09/2009)	Intel 8.15.10.1855 (07/28/2009)	Intel 8.15.10.1855 (07/28/2009)
Sound card/subsystem					
Vendor and model number	IDT High Definition Audio	IDT High Definition Audio	ATI High Definition Audio Device	SoundMAX Integrated Digital HD Audio	SoundMAX Integrated Digital HD Audio
Driver	IDT 6.10.6257.0 (11/18/2009)	IDT 6.10.6246.0 (10/12/2009)	ATI Technologies Inc. 5.0.7000.7 (08/23/2009)	AnalogDevices 6.10.1.7255 (05/18/2009)	AnalogDevices 6.10.1.7255 (05/18/2009)
Ethernet					
Vendor and model number	Intel 82577LM Gigabit	Marvell Yukon 88E8072 PCI-E Gigabit	Marvell Yukon 88E8072 PCI-E Gigabit	Intel 82567LM Gigabit	Marvell Yukon 88E8072 PCI-E Gigabit
Driver	Microsoft 11.5.4.0 (11/05/2009)	Marvell 11.10.7.3 (07/20/2009)	Microsoft 11.0.5.3 (02/23/2009)	Microsoft 10.0.2.2 (08/18/2008)	Marvell 11.10.7.3 (07/20/2009)

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System	Intel Core i5-520M-based notebook	Intel Core i5-430M-based notebook	AMD Turion II Ultra-based notebook	Intel Core 2 Duo P8700-based notebook	Intel Core 2 Duo T6670-based notebook
Wireless					
Vendor and model number	Intel Centrino Advanced-N 6200 AGN	Intel WiFi Link 1000 BGN	Broadcom 802.11b/g WLAN	Intel WiFi Link 5300 AGN	Intel WiFi Link 5100 AGN
Driver	Intel 13.0.0.107 (9/15/2009)	Intel 13.0.0.107 (9/15/2009)	Broadcom 5.30.21.0 (7/7/2009)	Intel 12.4.1.11 (5/14/2009)	Intel 13.0.0.107 (9/15/2009)
Optical drive(s)					
Vendor and model number	HP DVDRAM GT30L	HP DVD RW AD-7701H	HP DVD RW AD-7561S	HP DVD RW AD-7561S	HP DVD RW AD-7561S
Type	DVDRW	DVDRW	DVDRW	DVDRW	DVDRW
Interface	Serial-ATA	Serial-ATA	Serial-ATA	Serial-ATA	Serial-ATA
Dual/Single layer	Dual	Dual	Dual	Dual	Dual
USB ports					
Number	4	4	4	3	4
Type	2.0	2.0	2.0	2.0	2.0
IEEE 1394 ports					
Number	0	0	0	0	0
Monitor					
LCD type	LED	LED	LED	WXGA	LED
Screen size (inches)	14.0	14.0	14.0	14.1	15.6
Refresh rate (Hz)	60	60	60	60	60
Battery					
Type	HP HSTNN-IB69 Lithium-Ion	HP HSTNN-IB69 Lithium-Ion	HP HSTNN-IB69 Lithium-Ion	HP HSTNN-CB69 (E1) Lithium-Ion	HP HSTNN-OB89 Lithium-Ion
Size (length x width x height)	5 in x 1.625 in x 0.75 in	5 in x 1.625 in x 0.75 in	5 in x 1.625 in x 0.75 in	8 in x 1.625 in x 0.75 in	10.5 in x 1.625 in x 0.75 in
Rated capacity	10.8V / 4910mAh / 53Wh	10.8V / 4910mAh / 53Wh	10.8V / 4910mAh / 53Wh	10.8V / 5100 mAh / 55Wh	14.4V / 4400 mAh / 63Wh
Weight (lb)	.71	.71	.71	.70	.90

Figure 5: Notebook test system configurations.[1]

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[1] Changing a system's hard drive or memory configuration can cause different benchmark results.

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About Principled Technologies

We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

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.

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