

Performance and energy consumption of notebook PCs with Intel* and AMD* processors (Vendor 1)

Executive summary

Intel Corporation* (Intel) commissioned Principled Technologies* (PT) to run a set of performance, energy consumption, and battery life tests on a pair of notebook systems that came from the same vendor and used the following processors:

- AMD* Turion* 64 X2 TL-60 2.0GHz (System A)
- Intel Core 2 Duo® T7300 2.0GHz (System B)

The goal of the testing was to gauge the performance, energy consumption, and battery life that buyers would experience when performing common tasks under the Windows* Vista* operating system. Intel specified the test systems and provided the tests, test procedures, and test settings. PT purchased and set up the systems and executed all tests during October 2007.

We measured Windows Vista system performance using BAPCo* MobileMark* 2007 Productivity, an industry-standard benchmark that provides a performance score as well as a Battery Life rating. We ran MobileMark on the systems two ways: in their out-of-the-box (OOB) configurations and with their settings enhanced by PT to maximize battery life (possibly at the expense of performance).

We also measured Windows Vista system performance and energy consumption with a consumer application test: Microsoft Office Excel* 2007 Big Number Crunch, which uses Excel to recalculate a spreadsheet.

The Key Findings box summarizes the test results. The Test results section shows those results in more detail, while the Test methodology section explains how we ran the tests. Appendix A provides the price of the test systems, and Appendix B details their configurations.

Test results

Figure 1 presents the median scores for each pair of systems we tested. We ran MobileMark 2007 three times on each system and the Excel 2007 spreadsheet recalculation five times on each. For MobileMark, we used the median of the Battery Life scores to determine the median Performance Qualification score. In the event of a tie, we chose the run with the higher Performance Qualification score. For Microsoft Office Excel 2007 Big Number Crunch, in the event of a tie we chose the run with the higher workload energy consumption (WEC). If the power consumption score was also tied, we chose the first run we executed that produced those scores.

For the MobileMark 2007 results, higher scores indicate better system performance. For the comparative ratings, which indicate the advantage one system has over the system, higher scores are also better.

For all three scores for the Microsoft Office Excel 2007 Big Number Crunch test—the time it took to complete the workload (in seconds), the average DC Power (in Watts), and the workload energy consumption (in Watts per hour)—lower scores are better.

KEY FINDINGS

- With both out-of-the-box and PT-enhanced Windows Vista settings, the system with the Intel Core 2 Duo T7300 processor achieved 52 percent better MobileMark battery life and 55 to 65 percent better MobileMark performance than the system with the AMD Turion 64 X2 TL-60 processor (see Figure 1).
- Using PT's enhanced Windows Vista settings did indeed increase battery life 10 percent on both systems but with the trade-off of a performance loss of 50 to 52 percent.
- On the Microsoft Office Excel 2007 Big Number Crunch workload, System B, with the Intel Core 2 Duo T7300 processor, achieved 213 percent better performance, 7 percent better average DC power, and 237 percent better workload energy consumption than did System A, with the AMD Turion 64 X2 TL-60 processor (see Figure 2).

We used the Extech Instruments* 380803 Power Analyzer* to gauge energy consumption. The Extech Power Analyzer is an external unit that connects to a host computer through a RS-232 communications cable. Additionally, this device has a DC power cable that powers the system under test. We used the Extech Power Analyzer to monitor the average DC energy consumption of each system while running the custom consumer application test. We then multiplied the Extech's average DC power score by the time the workload took to complete to calculate the workload energy consumption in Watt-seconds. We divided the WEC Watt-seconds score by 3,600 (the number of seconds in an hour) to calculate the WEC Watt-hours we reported below.

Screen brightness can affect the amount of energy a system consumes. For our pair of comparison systems, we set the brightness of the brighter system to match as closely as possible the brightness of the dimmer system. Consequently, the Intel processor-based system was actually slightly brighter than the AMD processor-based comparison system. The nits measurements in parentheses below each system name in Figures 1 through 3 give the brightness at which we tested each system.

As Figure 1 shows, with both out-of-the-box and PT-enhanced settings, System B, with Intel Core 2 Duo T7300 processor achieved 52 percent better MobileMark battery life and 55 to 65 percent better MobileMark performance than System A, with the AMD Turion 64 X2 TL-60 processor.

Using PT's enhanced Windows Vista settings increased battery life 10 percent on both systems, which was the intent of those settings. The trade-off was a performance loss of 50 percent on System A, with the AMD Turion 64 X2 TL-60 processor, and 52 percent on System B, with Intel Core 2 Duo T7300 processor.

Benchmark or Test	Performance results		Comparative ratings	
	System A with AMD Turion 64 X2 TL-60 2.0GHz processor (60 nits)	System B with Intel Core 2 Duo T7300 2.0GHz processor (61 nits)	System A with AMD Turion 64 X2 TL-60 2.0GHz processor (60 nits)	System B with Intel Core 2 Duo T7300 2.0GHz processor (61 nits)
Industry-standard benchmark	Higher numbers are better		Higher numbers are better	
BAPCo MobileMark 2007 Performance Qualification score	111 (OOB)	183 (OOB)	1.00 (OOB)	1.65 (OOB)
	56 (PT)	87 (PT)	1.00 (PT)	1.55 (PT)
BAPCo MobileMark 2007 Battery Life score (minutes)	273 (OOB)	415 (OOB)	1.00 (OOB)	1.52 (OOB)
	300 (PT)	456 (PT)	1.00 (PT)	1.52 (PT)

Figure 1: Median scores and comparative performance and battery life ratings for the test systems.

As Figure 2 shows, when executing the Microsoft Office Excel 2007 Big Number Crunch workload, System B, with the Intel Core 2 Duo T7300 processor, achieved 213 percent better performance, 7 percent better average DC power, and 237 percent better workload energy consumption than did System A, with the AMD Turion 64 X2 TL-60 processor.

Benchmark or Test	Performance results		Comparative ratings	
	System A with AMD Turion 64 X2 TL-60 2.0GHz processor (60 nits)	System B with Intel Core 2 Duo T7300 2.0GHz processor (61 nits)	System A with AMD Turion 64 X2 TL-60 2.0GHz processor (60 nits)	System B with Intel Core 2 Duo T7300 2.0GHz processor (61 nits)
Custom consumer application test	Lower numbers are better		Higher numbers are better	
Microsoft Office Excel 2007 Big Number Crunch (seconds)	50 (OOB)	16 (OOB)	1.00 (OOB)	3.13 (OOB)
Average DC Power (Watts)	45.93 (OOB)	42.82 (OOB)	1.00 (OOB)	1.07 (OOB)
Workload Energy Consumption (WHR)	0.64 (OOB)	0.19 (OOB)	1.00 (OOB)	3.37 (OOB)

Figure 2: Median scores and comparative performance and battery life ratings for the test systems.

Test methodology

This section discusses some differences in the configurations of the test systems and details the methodologies we followed in testing them. We ran MobileMark 2007 three times and each consumer custom test five times; we report the median of those runs.

Configuration differences

We purchased the built-to-order systems from the vendors' Web sites. We made them as identical as possible and as close in price as possible, but we could not avoid the following differences:

- The hard drive controllers in the systems differ.
- The graphics controllers in the systems differ.
- The prices differ.

For more detailed pricing information, see Appendix A. For more details on the system configurations, see Appendix B.

Initial setup

When the systems arrived, we unpacked and set up each one. We went through the following process with the Windows Vista Business systems the first time we booted it:

1. At the Set up Windows screen, select United States, English and U.S. keyboard, and click Next.
2. At the Microsoft and Manufacturer End User License Agreements, select Yes, I accept them, and click Next.
3. Type a user name.
4. Leave the password blank, and click Next.
5. Name the computer with its model, and click Next.
6. At the Help protect Windows automatically screen, click Ask me later (because our goal is to test each PC as it came directly out of the box).
7. At the Review your time and date settings, select Eastern Time, and click Next.
8. At the Thank you screen, click Start.
9. At the manufacturer's support software license screen, click I agree.

Capturing an image of the hard drive

We used Symantec's Ghost product to capture an exact image of the hard disk. Each time we ran a new benchmark or test on a machine, we used the Ghost image to return that machine to the above configuration. After re-imaging, we installed the software necessary to run each test and rebooted. We followed this process to capture the image:

1. Restart the computer.
2. Insert a bootable network CD.

3. At the Current Configuration dialog screen, press the Escape key to accept the automatic network options.
4. At the DOS command prompt, use the net use command to map a network drive to the dedicated Ghost image server, i.e., type `net use z: \\ghostserver\ghost`, and press Enter.
5. Type `z:` to change to the mapped drive.
6. Type `ghost`, and press Enter.
7. At the Symantec Ghost screen, click OK.
8. Select Local→Disk→To Image.
9. Click OK.
10. Select the Primary disk, and click OK.
11. Click Save.
12. At the Compress Image dialog, select Fast.
13. At the Proceed dialog, select Yes.
14. When the ghost image is complete, click OK, and exit Ghost.
15. Reboot the computer.

Extech Power Analyzer setup and test procedure

We did the following to set up the Extech Power Analyzer and software:

1. Power off and remove the battery from the notebook PC under test.
2. Connect the power cord from the Kensington Universal 120W AC/DC to the Power Analyzer's DC output load power outlet.
3. Plug the power cord from the Power Analyzer's DC input voltage connection into a power outlet.
4. Connect a separate host computer to the Power Analyzer using an RS-232 cable. This computer will monitor and collect the power measurement data.
5. Turn on the Extech Power Analyzer by pressing the green On/Off button.
6. Turn on the host computer.
7. Insert the Extech software installation CD into the host computer, and install the software as follows:
 - a. Using Windows Explorer, browse to the Extech Power Analyzer installation CD, and click Setup.exe.
 - b. At the Welcome to the Power Analyzer screen, click OK.
 - c. At the installation screen, leave the default installation directory, and click the icon button to begin installation.
 - d. At the Setup has completed successfully screen, click OK.
8. Launch the Extech Power Analyzer software by clicking Start→All Programs→Power Analyzer.
9. At the Select COM port dialog, click OK.
10. From the top menu, select Option→COM, then select COM1.
11. Exit the Extech Power Analyzer software.

We did the following to measure energy consumption during a test:

1. Power on the notebook PC, and make sure we have prepped it to run a test.
2. On the host computer, launch the Extech Power Analyzer software by going to Start→All Programs→Power Analyzer.
3. From the top menu, click Option→Sample Rate, type `1.0`, and click OK.
4. From the top menu, click File→Name.
5. In the Name field, type a name that appropriately describes the platform and configuration, and click OK.
6. To begin recording power, click File→Start Recording→Now (Auto) at the same time we start a test.
7. To stop recording power, click File→End Recording at the same time we stop a test.

To view the power measurement data, double-click the My Computer desktop icon→select the C: drive→Program Files→Power Analyzer. When the program launches, select the test name you selected earlier, and double-click that file name. To open the file, select Excel as the program for viewing the data. This is the file we will use to calculate the average power usage. We calculate average power usage by doing the following:

1. Use Windows Explorer to locate the log file. By default, the log file is saved in `C:\Program Files\Power Analyzer`.
2. Open the log file with Microsoft Excel.
3. Insert a column by right-clicking on column E and clicking Insert.
4. In cell E1, type `=value(left(D1,7))`, and press Enter.

5. Scroll down to the last row in column E and press Ctrl + Shift + Up. This should select the entire E column.
6. Press Ctrl + D to fill in column E.
7. Select cell A1 and press Ctrl + F.
8. In the Find What Field, type `0lw`, and click Find Next. This will find any outliers that may have occurred during the test.
9. Delete any row that produced an outlier.
10. In an empty cell, type `=average(e:e)`, and press Enter. This is the Average Power Draw in Watts.

PT enhanced power settings

We did the following steps for the PT enhanced power rundown:

1. Select the Windows Vista Power Saver Power Scheme.
2. Disable any wireless devices.
3. Turn off Indexing, by doing the following:
 - a. Click Start→Control Panel.
 - b. Click System and Maintenance.
 - c. Click Indexing Options.
 - d. Click Modify.
 - e. Uncheck all Indexed locations.
 - f. Close Indexing Options.
 - g. Click Start→Computer.
 - h. Right-click on any hard disks listed, i.e. Local Disk (C:).
 - i. Click Properties.
 - j. Uncheck the box next to Index the drive for faster searching.
 - k. Click Apply.
 - l. Select Apply changes to drive C:\, subfolders and files.
 - m. At any User Account Control (UAC) dialog, click Continue.
 - n. Click Ignore All to any error that appears during the process.
4. Turn off Windows Vista Sidebar, by doing the following:
 - a. Scroll the mouse over the Sidebar area.
 - b. Right-click and select Properties.
 - c. Uncheck the box next to Start Sidebar when Windows starts.
5. Adjust the Advanced Visual Effects options while keeping the Windows Aero Color scheme, by doing the following:
 - a. Click Start→Right-click on Computer.
 - b. Click on Properties.
 - c. Click Advanced System settings located in the Tasks column.
 - d. At the UAC dialog, click Continue.
 - e. Under the Performance section, click the Settings button.
 - f. Uncheck all the Visual Effects options except for the following:
 - g. Enable desktop composition
 - h. Enable transparent glass
 - i. Use visual styles on windows and buttons
6. Click Apply, and close any open dialog boxes.

BAPCo MobileMark 2007 v1.02

Figure 3 shows the error that MobileMark 2007 issued when we installed it on both systems as they came out of the box:

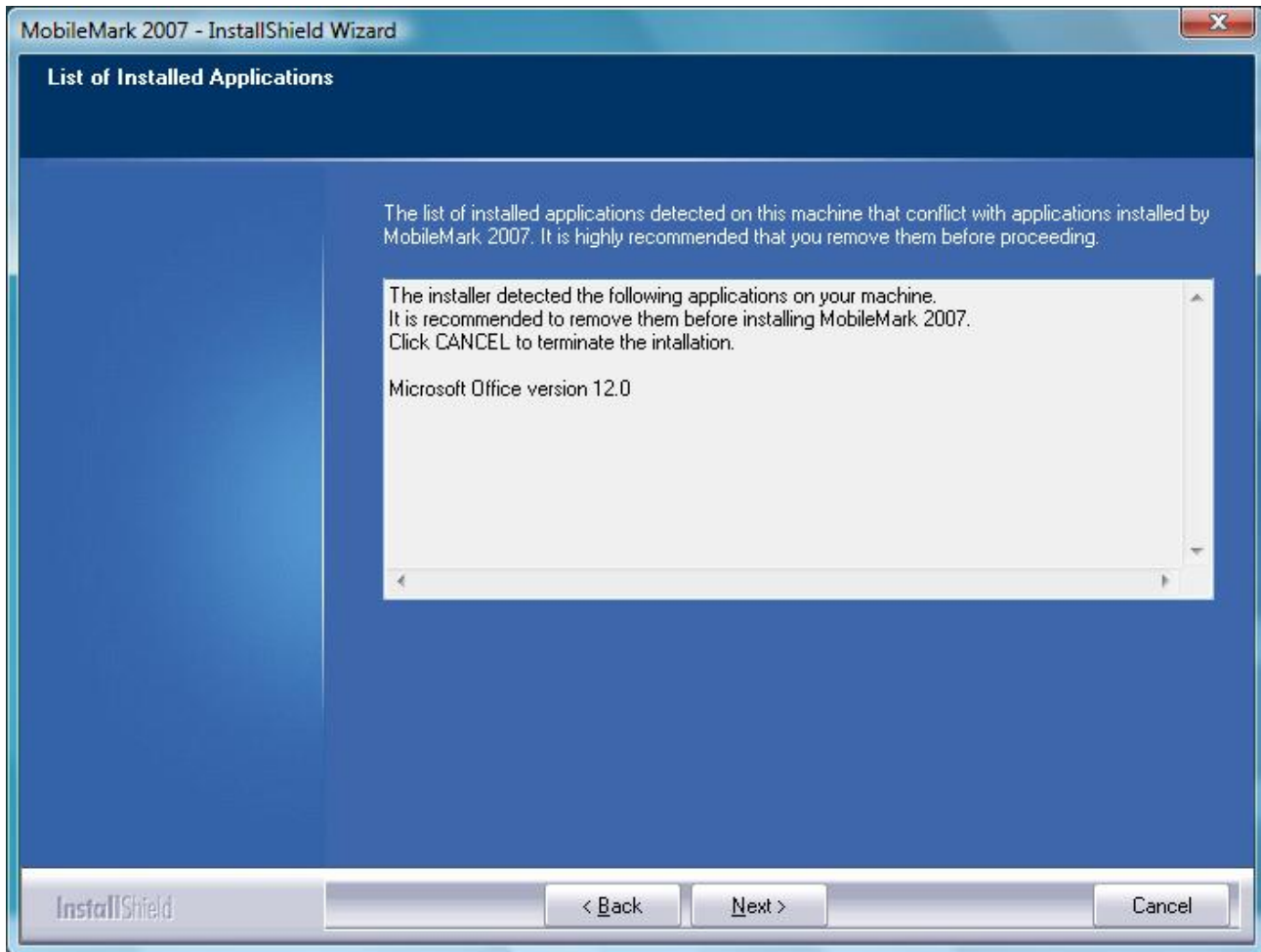


Figure 3: Microsoft Office message that appears during MobileMark 2007 installation.

So we could install MobileMark, we removed the preinstalled trial version of Microsoft Office 2007.

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

Setting up the test

1. Reset the system to the base test image.
2. Turn off the wireless network adapter by using the external toggle switch.
3. Uninstall Microsoft Office 2007.
 - a. Click Start→Control Panel→Programs→Uninstall a program →Microsoft Office 2007→Click Uninstall/Change.
 - b. At the User Account Control dialog, click Continue.
 - c. At the Are you sure you want to uninstall this product screen, click Yes.
4. Reboot the system.
5. Turn off User Account Control.
 - a. Click Start→type user accounts into the quick search field→Click Turn User Account Control on or off.
 - b. At the User Account Control dialog, click Continue.
 - c. Uncheck Use User Account Control to help protect your computer.

- d. Click OK.
- e. Click Restart Now.
6. Turn off Screen Saver and Power settings.
 - a. Right-click desktop→Personalize→Screen Saver→Select None from drop down menu and click Apply.
 - b. Click Change power settings.
 - c. Click Change plan settings.
 - d. At the Turn off the display and Put the computer to sleep drop-down menus, select Never.
 - e. Click Change advanced power settings.
 - f. Under display options set:
 - i. Adaptive display to Off.
 - ii. Screen brightness to above 60 nits.
 - g. Under Battery options set:
 - i. Critical battery action to Shut down.
 - ii. Low battery level to 0%.
 - iii. Critical battery level to 0%.
 - iv. Low battery notification to Off.
 - v. Low battery action to Do nothing.
7. Purchase and install MobileMark 2007 v1.02 with default settings from: <https://www.bapcostore.com/store/product.php?productid=16173&cat=250&page=1>.
 - a. At the Welcome to InstallShield Wizard screen, click Next.
 - b. At the License Agreement screen, select I accept the terms in the License Agreement, and click Next.
 - c. At the Destination Folder screen, leave the default, and click Next.
 - d. At the Ready to Install the Program screen, click Install.
 - e. A screen will appear indicating that the installation was successful.
8. Reboot the system.

Running the test

1. Launch MobileMark 2007 by clicking the MobileMark 2007 desktop icon.
2. Select Productivity on the left-side.
3. Enter a name for that run, and click Next.
4. At the Benchmark check screen, click Next.
5. At the Hibernation Check screen click yes to turn off Hibernation.
6. At the Preparing a new test screen, click Next.
7. Unplug the notebook when instructed to begin the benchmark.
8. When the notebook turns off, plug the notebook back in.
9. Record the Performance Qualification and Battery Life results.

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 the test

1. Reset the system to the base test image.
2. Copy the BigNumberCrunch.xlsm test file to the 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. Select I want to activate the software over the Internet, and click Next.
6. Click Finish.
7. Uncheck Search Microsoft Office Online for Help content when I'm connected to the Internet, and click Next.
8. Select I don't want to use Microsoft Update, and click Finish.

9. Click the Microsoft Office button located in the top left.
10. Click Excel Options.
11. Click Trust Center located in the left column.
12. Click the Trust Center Settings button.
13. Click Macro Settings located in the left column, and select Enable all macros.
14. Click OK.
15. Close Excel.
16. Delete the contents of C:\Windows\Prefetch.
17. Reboot the system.
18. Right-click the taskbar and select Task Manager.
19. Click the Performance tab.
20. Click the Resource Monitor button.
21. Watch Disk Monitor. When there are no more disk requests close Resource Monitor.
22. Open an Administrative Command Prompt by clicking Start→All Programs→Accessories→Right-click Command Prompt→Select Run as administrator.
23. Type `rundll32.exe advapi32.dll,ProcessIdleTasks`.
24. Right-click the taskbar and select Task Manager.
25. Click the Processes tab. When `rundll32.exe` no longer appears, the system is ready to start testing.
26. On the host computer, launch the Extech Power Analyzer software by clicking Start→All Programs→Power Analyzer.
27. From the top menu, click Option→Sample Rate, type 1.0, and click OK.
28. From the top menu, click File→Name.
29. In the Name field, type a name that appropriately describes the platform and configuration, and click OK.

Running the 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 `BigNumberCrunch.xlsm` workload file, and click Open.
4. Press Ctrl + R while at the same time starting the Extech Power Analyzer by clicking File→Start Recording→Now (Auto).
5. When the results dialog appears, stop the Extech Power Analyzer by clicking File→End Recording.
6. Record the results, and click OK.
7. Close Excel. Click No to saving results made to file.
8. Repeat the steps four more times without rebooting between runs.

Appendix A – System pricing

Figure 4 presents the prices, excluding taxes and shipping, that we paid for the test systems on October 7, 2007.

System	Unit price on 10/7/2007	Instant rebate on 10/7/2007	Total we paid on 10/7/2007
System A: Dell Vostro 1000 AMD Turion 64 X2 TL-60 2.0GHz	\$1,123.00	\$135.00	\$988.00
System B: Dell Vostro 1500 Intel Core 2 Duo T7300 2.0GHz	1,177.00	50.00	1,127.00

Figure 4: Prices, excluding tax and shipping, PT paid for the test systems on October 7, 2007.

Appendix B – Test system configuration information

This appendix provides detailed configuration information about each of the test notebook PCs, which we list in alphabetical order.

System	System A Dell Vostro 1000 AMD Turion 64 X2 TL-60 2.0GHz	System B Dell Vostro 1500 Intel Core 2 Duo T7300 2.0GHz
General		
Processor and OS kernel: (physical, core, logical)/(UP, MP)	1P2C2L / MP	1P2C2L/MP
Number of physical processors	1	1
Single-/dual-core processors	Dual	Dual
System power management policy	Manufacturer recommended	Manufacturer recommended
Processor power-saving option	AMD PowerNow! Technology	Enhanced Intel SpeedStep Technology
System dimensions (length x width x height)	14" x 10¼" x 1¾"	14" x 11¼" x 1¾"
System weight	6 lbs. 10 oz.	6 lbs. 12 oz.
CPU		
Vendor	AMD	Intel
Name	Turion 64 X2	Core 2 Duo
Model number	TL-60	T7300
Stepping	1	A
Socket type	Socket S1	Socket P
Core frequency (GHz)	2.0	2.0
Front-side bus frequency	1,600 MHz HyperTransport Technology	800 MHz
L1 cache	64 KB + 64 KB (per core)	32 KB + 32 KB (per core)
L2 cache	1 MB (512 KB per core)	4 MB (shared)
Platform		
Motherboard model number	Manufacturer 0WY383	Manufacturer 0NX907
Motherboard chipset	ATI RS480	Intel GM965
Motherboard revision number	10	C0
System serial number	2DDZWD1	GRD9XD1
Bios name and version	Manufacturer 2.5.2	Manufacturer A01
BIOS settings	Default	Default
Memory module(s)		
Vendor and model number	Mosel V916765G24QBFW-E4	Nanya NT1GT64U8HB0BN
Type	PC2-4200	PC2-5300
Speed (MHz)	533	667
Speed running in the system (MHz)	266	333

System	System A Dell Vostro 1000 AMD Turion 64 X2 TL-60 2.0GHz	System B Dell Vostro 1500 Intel Core 2 Duo T7300 2.0GHz
Timing/Latency (tCL-tRCD-tRP-tRASmin)	4-4-4-12	5-5-5-15
Size	2,048 MB	2,048 MB
Number of memory module(s)	2 x 1,024 MB	2 x 1,024
Chip organization (single- or double-sided)	Double-sided	Double-sided
Channel (single/dual)	Dual	Dual
Hard disk		
Vendor and model number	Seagate ST980811AS	Western Digital WD800BEVS-75RST0
Size	80 GB	80 GB
Buffer size	8 MB	8 MB
RPM	5,400	5,400
Type	SATA 150 Mb/s	SATA 150 Mb/s
Controller	ATI SB600	Intel 82801HBM (ICH8-ME)
Driver	Microsoft 6.0.6000.20580	Intel 7.0.0.1020
Operating system		
Name	Windows Vista Business	Windows Vista Business
Build number	6000	6000
File system	NTFS	NTFS
Kernel	ACPI x86-based PC	ACPI x86-based PC
Language	English	English
Microsoft DirectX version	DirectX 10	DirectX 10
Graphics		
Vendor and model number	ATI Radeon Xpress 1150	Intel GMA X3100
Type	Integrated	Integrated
Chipset	ATI Radeon Graphics Processor	Intel 965 Express Chipset Family
BIOS version	BK-ATI VER008.0501.058.002	1466
Total available graphics memory	831 MB	358 MB
Dedicated video memory	128 MB	0 MB
System video memory	0 MB	128 MB
Shared system memory	703 MB	230 MB
Resolution	1,280 x 800	1,280 x 800
Driver	ATI 8.351.0.0	Intel 7.14.10.1272
Sound card/subsystem		
Vendor and model number	SigmaTel High Definition Audio	SigmaTel High Definition Audio
Driver	SigmaTel 6.10.0.5407	SigmaTel 6.10.0.5511
Ethernet		
Vendor and model number	Broadcom 440x 10/100	Broadcom 440x 10/100
Driver	Broadcom 4.60.0.0	Broadcom 4.60.0.0

System	System A Dell Vostro 1000 AMD Turion 64 X2 TL-60 2.0GHz	System B Dell Vostro 1500 Intel Core 2 Duo T7300 2.0GHz
Wireless		
Vendor and model number	Wireless 1490	Intel PRO/Wireless 3945ABG
Driver	Broadcom 4.102.15.61	Intel 11.1.1.22
Modem		
Vendor and model number	Conexant HDA D330 MDC V.92	Conexant HDA D330 MDC V.92
Driver	Conexant 7.59.0.0	Conexant 7.59.0.0
Optical drive(s)		
Vendor and model number	LG GSA-T11N	Sony CRX880A
Type	DVD-RW	DVD-ROM/CD-RW
USB ports		
Number	4	4
Type	USB 2.0	USB 2.0
Other	Media card reader	Media card reader
IEEE 1394 ports		
Number	0	1
Monitor		
LCD type	WXGA	WXGA
Screen size	15.4"	15.4"
Refresh rate	60 Hz	60 Hz
Battery		
Type	Manufacturer KD476 lithium ion	Manufacturer FK890 lithium ion
Size (length x width x height)	8¼" x 2" x 1 7/8"	8¼" x 2¾" x 1 7/8"
Rated capacity	7,700mAh/11.1V (85Wh)	7,700mAh/11.1V (85Wh)
Weight	1 lb.	1 lb.

Figure 5: Detailed system configuration information for the Dell test notebook PCs.



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