
A guide to improving benchmarking for battery life of notebook PCs

Measuring Battery Life For Today's Notebook PCs

Today, notebook PC customers are frequently presented with a single battery life benchmarking score that is gathered using light workloads and a relatively idle CPU. This single score does not take into account how a notebook PC battery may perform when the battery is used in a more “active” state, such as when a notebook PC is running sophisticated graphics or performing complex computations.

There is currently no single benchmark test available for notebook battery life that accurately reflects real-life usage patterns. Adding data gathered using a heavier workload and an active CPU to the currently used benchmark score can provide a more realistic gauge of battery life in notebook PCs—and this additional data is easily provided by existing mainstream benchmarking tests.

The goal of this white paper is to encourage a more transparent discussion around battery life benchmarking for notebook PCs. By evaluating benchmarking results from multiple tests, such as the BAPCo® MobileMark® 2007 test and the Futuremark® 3DMark®06 test, it is possible to get a more balanced view, incorporating both “idle” and “active” system states. This paper provides step-by-step guidance for running the two benchmarks so that notebook PC customers can obtain more realistic battery life estimates.

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BENCHMARKING NOTEBOOK PC BATTERY LIFE

Benchmarking results are one of the most common ways that consumers gauge the real-world performance of notebook PCs; the scores provide a fast, easy way to make comparisons between the characteristics of the systems consumers are considering for purchase.

However, while benchmarking results are frequently presented and widely advertised, a concrete explanation of what the results truly mean is often missing. A good benchmark helps provide an accurate measurement of how a computing system will be used, and it provides enough data points to help customers accurately assess whether or not a system is appropriate for their needs. Benchmarking should be guided by *transparency*, providing insight into the characteristics being measured, and *repeatability*, providing enough information so that the results can be consistently duplicated.

BATTERY LIFE BENCHMARKING

Most battery life metrics today are obtained by measuring how long the battery lasts running one particular benchmark: MobileMark® 2007, a benchmark distributed by the Business Applications Performance Corporation (BAPCo®) consortium.

In general terms, a battery life score is obtained by unplugging a fully charged notebook PC and recording the time at which battery depletion causes the computer to power down. What the computer is doing while it is running on the battery, however, varies depending on the benchmarking test.

The MobileMark 2007 benchmark, for example, rates battery life when a PC is running at less than 10 percent utilization on average—a mostly idle CPU—thereby presenting only one side of the battery life story.

What affects battery life?

Battery life is affected by many factors. The CPU and the display consume most of the power in a typical notebook PC. Other components, such as the memory, the hard drive, the chipset, and the graphics, affect the battery life of notebook PCs. Application usage also affects the life of the battery, especially using applications making heavy use of graphics.

Almost all notebooks today have built-in wireless capabilities that affect battery life. If the computer is searching for a wireless connection, or if the user is constantly dropping the connection and trying to reconnect, the wireless card must work harder, and the effect on the battery life is measureable. However, simply turning the wireless connection on does not drain much power

It can therefore be difficult to quantify the impact of wireless on battery life. Finally, the enabling technology used for the battery (for example, lithium polymer or lithium ion) and the battery's capacity also play a role in determining battery life.

It is important to note that some manufacturers design their computers to turn off before the battery is fully depleted. This ensures that the operating system can save all of the data before the battery fails. These types of features can affect the battery life rating reported by benchmarking tests.

Why are more data points needed?

Expanding battery life benchmarking by adding additional tests that gather data when the notebook PC is being more fully utilized can provide customers with a more comprehensive set of data.

A good analogy for multiple sets of data is found in mobile phones. Customers have come to expect values for “standby time” and “talk time” when looking at mobile phone battery life, and customers understand that these values will vary widely. A mobile phone may have an expected 300 hours of standby time, but only about 5 hours of talk time—and this value decreases if Wi-Fi, GPS, or other features are turned on. Customers do not choose a mobile phone based on a single benchmark; customers look at the standby time and talk time numbers to get a more complete picture of what battery life they can expect.

Another good analogy for multiple sets of benchmark data is found in automobile gas mileage. Customers expect different values for gas mileage when looking at vehicles. “City miles” and “highway miles” are, of course, very different—and customers are accustomed to considering both when evaluating gas mileage.

In the same way, adding data that is measured when a notebook PC is in a more active state can give a better, more complete picture of battery life in notebook PCs. AMD believes consumers will benefit from both “idle” and “active” metrics when making decisions in the future.

THE CURRENT STANDARD: MOBILEMARK® 2007

As noted, the most commonly used benchmark for measuring notebook PC battery life is MobileMark® 2007 from the BAPCo® consortium, which consists of member companies from across the PC industry including AMD.

Though originally designed to be a battery life benchmark for the commercial segment, MobileMark has come to be used for benchmarking consumer notebooks as well.

The MobileMark 2007 benchmark consists of three individual tests: Productivity, Reader, and DVD modules.

- The Productivity module implements common office activities, including document management, data processing, file management, and rich content creation.
- The Reader module contains a light-activity workload, modeling a user reading through a document. The compressed, content-protected document is read at a pace of one page per two minutes.
- The DVD module makes it possible for users to evaluate the battery life of a notebook while engaged in DVD playback, such as when playing a movie.

The Reader and DVD modules of MobileMark 2007 by definition incorporate large amounts of inactive time into their testing. The Productivity module also incorporates idle time because users sometimes leave their systems unused between sessions of active use. The benchmark simulates this behavior by performing a small series of operations and then making the system sit idle for a while before starting the next task. In tests run in AMD labs, idle time, with an inactive CPU, typically averaged more than 90 percent of the time the system is running on the battery. For this reason, the MobileMark 2007 score can be impressive, but does not accurately reflect what consumers will actually experience at home.

ADDING DATA: 3DMARK®06

While not originally designed to be used as a battery life benchmark, the Futuremark® 3DMark06 benchmark can log the active battery life of a notebook PC with the addition of a few scripts, providing additional data points. 3DMark06® is a benchmark that actively uses the major components in the system—including the CPU and the GPU—and is a good test to demonstrate active usage of a notebook.

The 3DMark06 benchmark runs on the Windows® XP and Windows Vista® operating systems. Most importantly, 3DMark06 keeps the notebook utilizing key components such as CPU, GPU, and system memory at high workloads—providing very different information than MobileMark® 2007 does. The 3DMark06 test provides a wide range of benchmark settings and professional tools for image quality inspection, texture filtering quality testing, and automated batch runs.

While neither benchmarking test provides full information, adding the 3DMark06 active results to the MobileMark 2007 idle results

can provide customers with a more balanced view of battery life in the systems they are considering.

RUNNING THE BENCHMARKS – A STEP-BY-STEP GUIDE

AMD aims to broaden the discussion around battery life benchmarks, and AMD recommends running both active and idle benchmark tests to get full information about battery life. The instructions for running these tests follow:

PREPARE THE SYSTEM

For the following guidance, it is assumed that:

- You use Windows Vista Service Pack 1 (SP1) (32-bit) in the default installation configuration.
- You have a basic understanding of how to install and use benchmarks.

Disable the User Account Control feature

1. Click **Start**, point to **Control Panel**, point to **User Accounts**, and then click **Turn User Account Control on or off**.
2. Clear the **Use User Account Controls (UAC) to help protect your computer** check box.
3. Reboot the computer.

Disable the Disk Defragmenter

1. Click **Start**, point to **All Programs**, point to **Accessories**, point to **System Tools**, and then click **Disk Defragmenter (Dfrgui.exe)**.
2. Uncheck **Run on a schedule (recommended)**, and then click **OK**.

Configure the operating system power scheme

Configure the system and maintenance settings.

1. Click **System**, and then click **Advanced System Settings**.
2. Under **Remote**, uncheck **Allow Remote Assistance connections to this computer**.
3. Under **System Protection**, make the following settings:
 - a. Uncheck all available disks.
 - b. Uncheck **Turn System Restore Off** when prompted.
4. Click **Advanced**, point to **Performance**, and then click **Settings**.
 - a. Select **Adjust for best appearance**.
 - b. Click **OK**.
5. Click **OK**.
6. Click **Administrative Tools**, point to **Task Scheduler**,

- point to **Task Scheduler Library**, point to **Microsoft**, and then click **Windows**.
- 7. Under **Defrag**, disable all items, and then delete all scheduled defrag items.
- 8. Under **Remote Assistance**, disable and then delete all items.
- 9. Under **System Restore**, delete all items.
- 10. Close **Task Scheduler**.

Configure the Appearance and Personalization settings.

1. Under **Screen Saver**, select **Screen saver: (None)**.
2. Click **Power management**, point to **Change power settings**, and then click **MobileMark® 2007**.
3. Change the plan settings to the following:
 - a. Set **Turn off the display** to **Never, Never**.
 - b. Set **Put the computer to sleep** to **Never, Never**.
 - c. Change the **Advanced power settings** to the following:
 - i. Set **Require a password on wakeup** to **No** for all.
 - ii. Under **Hard disk**, set **Turn off hard disk after** to **3 minutes**.
 - iii. Under **Wireless Adapter Settings**, set **Power Saving Mode** to **Maximum Power Saving**.
 - d. Change the **Sleep** settings to the following:
 - i. Set **Sleep after** to **Never (0 minutes)**.
 - ii. Set **Allow hybrid sleep** to **Off**.
 - iii. Set **Hibernate after** to **Never (0 minutes)**.
 - iv. Under **USB settings**, set the **USB selective suspend setting** to **Enabled**.
 - e. Change the **Power buttons and lid** settings to the following:
 - i. Set **Lid close action** to **Do nothing**.
 - ii. Set **Power button action** to **Do nothing**.
 - iii. Set **Sleep button action** to **Do nothing**.
 - iv. Set **Start menu power button** to **Shut down**.
 - f. Under **PCI Express**, set **Link State Power Management** to **Maximum power savings**.
 - g. Change the **Processor power management** settings to the following:
 - i. Set **Minimum processor state** to **5%**.
 - ii. Set **Maximum processor state** to **100%**.
 - h. Under **Search and Indexing**, set **Power Savings Mode** to **Power Saver**.
 - i. Change the **Display** settings to the following:
 - i. Set **Turn off display after** to **Never (0 minutes)**.
 - ii. Set **Adaptive display** to **Off**.
 - j. Under **Multimedia Settings**, set **When Sharing Media** to **Prevent idling to sleep on all**.

- k. Change the **Battery** settings to the following:
 - i. Under **Critical battery action**:
 1. Set **On battery** to **Shut down**.
 2. Set **Plugged in** to **Do nothing**.
 - ii. Set **Low battery action** to **0%**.
 - iii. Set **Critical battery level** to **0%**.
 - iv. Set **Low battery notification** to **Off**.
 - v. Set **Low Battery action** to **Do nothing**.
 - l. Change the **ATI Graphics** settings to the following:
 - i. Set **On battery** to **Maximum Battery life**.
 - ii. Set **Plugged in** to **Maximum Performance**.
 - m. Click **OK**.
4. Save the changes.
 5. Change the **Display** settings to the following:
 - a. Set **Resolution** to **NATIVE**.
 - b. Set **Colors** to **Highest (32 bit)**.
 - c. Under **Advanced Settings**, set **Monitor** to **Screen refresh rate** to **60Hertz**, and then click **OK**.
 - d. Click **OK**.
 6. Under **Windows Sidebar Properties**, uncheck **Start Sidebar when Windows starts**, and then click **OK**.

Configure the Security Center settings:

1. Under **Windows Update**:
 - a. Click **Never check for updates (not recommended)**.
 - b. Click **OK**, and then close **Windows Update**.
2. Under **Windows Firewall**:
 - a. Set **Turn Windows Firewall on or off** to **Off (not recommended)**.
 - b. Click **OK**, and then close **Windows Firewall**.
3. Click **Windows Defender**, point to **Tools**, and then click **Options**.
 - a. Under **Automatic scanning**, uncheck **Automatically scan my computer (recommended)**.
 - b. Under **Real-time protection options**, uncheck **Use real-time protection (recommended)**.
 - c. Under **Advanced options**:
 - i. Uncheck **Scan the contents of archived files and folders for potential threats**.
 - ii. Uncheck **Use heuristics to detect potentially harmful or unwanted behavior by software that hasn't been analyzed for risks**.
 - iii. Uncheck **Create a restore point before applying actions to detected items**.
 - d. Under **Administrator options**, uncheck **Use Windows Defender**.
 - e. Click **Save**, and then close **Windows Defender**.
4. Under **Change the way Security Center alerts me**, select **Don't notify me and don't display the icon (not recommended)**.

5. Change the **Malware protection** settings to the following:
 - a. Under **Virus protection**, click **Show me my available options**, and then select **Don't monitor my antivirus software state (not recommended)**.
 - b. Under **Spyware and other malware protection**, click **Show me my available options**, and then select **I have an antispysware program that I'll monitor myself**.
6. Click **Start**, point to **MSCONFIG**, and then disable all startup items.

You are now ready to install MobileMark® 2007. Place the shortcut icon on your desktop, and then set the screen brightness.

SET THE SCREEN BRIGHTNESS

Screen brightness greatly affects battery life, and therefore the screen brightness should be as consistent as possible when comparing the battery life of two systems. Brightness in a computer display is measured in "nits," units of visible-light intensity (one nit is equivalent to one candela per square meter).

In a lab environment, the brightness is measured with a nit meter in a completely dark room. Without a nit meter, consistency is difficult to obtain; setting the brightness to the middle setting for these tests, however, can still produce a significant range.

Note: For more information about setting up screen brightness, see:

<http://eblwg.org/pubdocs/Mobile%20PC%20Display%20Power%20Measurement%20Recommendations%20DSPMRv1.0.pdf>

1. Click **Start** → **All Programs** → **Accessories** → **Notepad**, and maximize the application window so that the screen is entirely white.
2. Unplug the AC power cord so that the system is running on the battery.
3. If a nit meter is available, place it on the LCD screen. The screen brightness should be set no lower than 60 nits. If a nit meter is not available, use the middle screen brightness setting.

RUN THE BAPCO® MOBILEMARK® 2007 TEST

MobileMark 2007 was designed as a benchmark for battery life and is easy to install and run.

1. Start the MobileMark 2007 benchmark using the icon on the desktop.

2. Select the **Productivity** workload option.
3. Follow the instructions provided. (If using a nit meter, verify that the brightness has adjusted to approximately 60 nits after you unplug the AC power cord to start the test.)

RUN THE FUTUREMARK® 3DMARK®06 TEST

3DMark 2006 was not designed to be used as a battery life benchmark; however, with the addition of several scripts, you can run the benchmark and log the time it ran to get a good measure of active battery life.

Create a battery life logging tool

Creating a battery life logging tool requires a folder for the battery life logging tool and two files: **timelog.bat** and **timelogconfig.txt**.

1. Using Windows® Explorer, open the **C:** drive.
2. Create a folder and name it **timelog**.
3. Create the file **timelog.bat** by opening Notepad and typing the following:

```
logman create counter perf_log -cf c:\
timelog\timelogconfig.txt -si 1 -f csv
-v mdddhmm
logman start perf_log
pause
logman stop perf_log
logman delete perf_log
```

4. Save the file to **C:\timelog** and name it **timelog.bat**.
5. Create a shortcut to the **timelog.bat** file and place it on the desktop.

Note: For more information on logman, see:

<http://technet.microsoft.com/en-us/library/bb490956.aspx>

6. Create the **timelogconfig.txt** file by opening Notepad and typing the following:

```
"\Processor(_Total)\% Processor Time"
"\Processor Performance (PPM_
Processor_0)\Processor Frequency
"\Processor Performance (PPM_
Processor_1)\Processor Frequency
```

7. Save the file to **C:\timelog** and name it **timelogconfig.txt**.

Install the benchmark

Install the 3DMark®06 benchmark using the default installation path and options. This will place an icon on the desktop.

Start the test and log the battery life

Start 3DMark06 via the icon on the desktop.

1. Click on the **Demo** button, and then make the following modifications:
 - a. Clear the **Sounds** checkbox.
 - b. Select the **Loop** checkbox.
2. Double-click on the shortcut to **timelog.bat** that you placed on the desktop.
3. Click on **Run** in the **3DMark 2006 Demo** box.

Both the logging script and 3DMark06 should now be running. Unplug the AC power cord, and ensure that the brightness is adjusted to approximately 60 nits (measure with a nit meter; alternately, use the middle setting for screen brightness).

Collect the results

The results file is located in the `C:\perflogs\username\` directory. The file name will be similar to **perf_log_03051404.csv**.

Review the collected data

Review the log file.

1. For ease, open the file in Microsoft® Office Excel® and remove the second line of the log file (this line does not contain useful data).
2. Note the starting time stamp, and then scroll to the bottom of the file and note the last time stamp.
3. Calculate the time between start and stop. This is the battery life of the computer.

REFERENCES

- Business Applications Performance Corporation: "MobileMark® 2007" March 2008:
http://www.bapco.com/techdocs/Mobilemark2007_Whitepaper.pdf
- Mobile PC Extended Battery Life Working Group: "Display Subsystem Power Measurement Recommendations" September 8, 2003:
<http://eblwg.org/pubdocs/Mobile%20PC%20Display%20Power%20Measurement%20Recommendations%20DSPMRv1.0.pdf>
- Futuremark® Corporation: "3DMark®06 Whitepaper v1.0.2" January 18, 2006:
http://www.futuremark.com/pressroom/companypdfs/3DMark06_Whitepaper_v1_0_2.pdf

Note also the additional information collected:

- **Time Stamps**
Each time the system logs specific information, it creates a time stamp that can be used for determining battery life.
- **% Processor Time**
The **% Processor Time** is the level of CPU utilization at the time of the data logging.
- **Processor Frequency**
The **Processor Frequency** is the CPU frequency at the time of the data logging.

SUMMARY

To compare the battery life of notebook PCs, consumers are commonly presented with a single benchmarking score that is based upon light workloads and only tells half of the story.

More accurate benchmarking results can be achieved by performing additional benchmarking tests, including the Futuremark® 3DMark®06, a benchmark based on an active system state, and the commonly used BAPCo® MobileMark® 2007 benchmark, which uses a more idle system state. Additional benchmark test results provide additional data points, giving consumers a more complete picture of what they can expect from the notebook PCs they purchase.