

# MobileMark<sup>®</sup> 2007

March, 2008  
Revision 1.0

BAPCo is a U.S. Registered Trademark of the Business Applications Performance Corporation. SYSmark, MobileMark and WebMark are U.S. Registered Trademarks of the Business Applications Performance Corporation. Copyright © 2008 Business Applications Performance Corporation. \*All other brand and product names appearing in this document are trademarks or registered trademarks of their respective holders.

BAPCo Benchmark Disclaimer: Business Applications Performance Corporation (BAPCo) is a non-profit, member organization of companies in the computing industry. Its mission is to create benchmark products that compare performance and/or battery life among computer systems, with particular view to business applications, as fairly and impartially as possible, in the light of the latest developments in technology and trends in usage. BAPCo products result from collaborative balancing and integration of technical input from participating members and experts, and reflect their professional judgment. We believe that BAPCo benchmarks are relevant and impartial measures for comparing general system performance and/or battery life on widely used business applications. BAPCo recognizes, however, that performance and/or battery life measures intrinsically involve subjective values, preferences, and priorities, which vary from user to user. BAPCo does not claim or warrant that the balances of system values, preferences, and priorities reflected in its benchmark products will coincide with those of any particular user.



## About BAPCo:

A non-profit consortium, BAPCo's charter is to develop and distribute a set of objective performance benchmarks based on popular computer applications and industry standard operating systems.

BAPCo stands for Business Applications Performance Corporation and its current members include: AMD, Apple, ARCintuition, Atheros Communications, CNET, Compal, Dell, Hewlett-Packard, Intel, Lenovo, Microsoft, NVIDIA, Sony, Toshiba, VIA Technologies, VNU Business Publications Limited (UK), ZDNet and Ziff Davis Media. BAPCo is a non-profit consortium with a charter to develop and distribute a set of objective performance benchmarks for personal computers based on popular software applications and operating systems.

## Table of Contents:

About BAPCo:.....	2
1.0 Introduction.....	4
2.0 Development Methodology .....	4
2.1 Identifying Usage Categories .....	5
2.2 Application and document types .....	5
2.3 Description of the modules.....	6
2.4 Constructing the Workload.....	7
2.5 Automation and Workload Integration.....	8
3.0 MobileMark 2007 Scoring Methodology.....	13
4.0 Features & Characteristics.....	14
4.1 MobileMark Usability Features & Execution Improvements .....	15
4.2 General Setting Requirements:.....	16
4.3 Considerations for DVD Module.....	16
4.4 Effect of Battery Degradation .....	17
5.0 Conclusion.....	18
APPENDIX A: Application Program Versions.....	19
APPENDIX B: MobileMark 2007 Screenshots.....	20
APPENDIX C: System configuration for the calibration system for MobileMark 2007 .....	24

## 1.0 Introduction

BAPCo is a non-profit consortium with a charter to develop and distribute a set of objective performance benchmarks based on popular computer applications and industry standard operating systems.

MobileMark<sup>®</sup> 2007 is the latest version of the premier notebook battery life benchmark, now with support for Microsoft Windows Vista\*. It builds upon BAPCo's extensive work in building benchmarks to evaluate platform technologies.

MobileMark 2007 contains a variety of workloads that represent a range of activities that a mobile worker may encounter.

Benchmarks designed by BAPCo are the result of cooperative development between industry leading companies from a variety of disciplines including publications, testing labs, PC manufacturers, and semiconductor manufacturing. BAPCo's array of members represents the breadth of the computing industry and harnesses a consortium of knowledge to better reflect today's and tomorrow's emerging business trends.

This document describes the strategies and methodologies deployed in the development of MobileMark 2007. It also provides tips on system configuration and test methodology that help ensure consistent, repeatable benchmark results. For instructions on how to install and run MobileMark 2007 please refer to the documentation provided on the installation DVD-ROM disc and the BAPCo website ([www.bapco.com](http://www.bapco.com)).

## 2.0 Development Methodology

BAPCo follows a development cycle in which it applies its standard development methodologies to a set of parameters driven by usage categories, usage models within the categories, software market segment indicators and technical feasibility. These parameters, along with the application of logical and physical workload characteristics, determine the composition of workloads in MobileMark.

The benchmark development process begins with identification of business usage categories of Personal Computers. Various usage models are then brought together as user interactions for each of the scenarios.

BAPCo domain experts and members join together in multiple development sessions to collaborate and develop the workload. BAPCo developers then implement the workload while satisfying benchmarking constraints to ensure correct implementation, relevant and objective workloads and feasible distribution of the benchmark.

## 2.1 Identifying Usage Categories

For MobileMark 2007, BAPCo identified these distinct usage types. Each of these usage types is represented by a module in MobileMark 2007.

### Productivity 2007:

MobileMark 2007 contains an all-new mobile productivity module that borrows from the new SYSmark 2007 Preview. SYSmark applications and workloads relevant to mobile platforms were chosen for inclusion in MobileMark. This module implements common office activities including document management, data processing, file management, and rich content creation.

### DVD 2007:

The DVD module allows users to evaluate the battery life of a notebook playing back a movie. The DVD-Video content for this module is based on the 3D animated short, *Elephants Dream* ([www.elephantsdream.org](http://www.elephantsdream.org)).

### Reader 2007:

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.

## 2.2 Application and document types

BAPCo identified the following applications and representative document types that the applications would operated on for each of the modules.

Application	Version	Document type
<b>DVD 2007</b>		
InterVideo* WinDVD*	8.0	DVD playback

*Table 1 – Applications for DVD 2007 module*

Application	Version	Document type
<b>Productivity 2007</b>		
Microsoft* Project*	2003	Project management
Microsoft* Excel*	2003	Calculation sheets
Microsoft* Outlook*	2003	Emails, calendars, scheduler
Microsoft* PowerPoint*	2003	Slide presentations
Microsoft* Word*	2003	Formatted text documents
WinZip Computing WinZip	Pro 10.0	Compressed Archives
Adobe*	CS2	Images,

Photoshop*		manipulated, compressed
Adobe* Illustrator*	CS2	Images manipulated
Adobe* Flash	8	Vector Graphics, Animation

**Table 2 –Applications for Productivity 2007 module**

Application	Version	Document type
<b>Reader 2007</b>		
Adobe* Reader*	6.01	e-book displayed on the screen

**Table 3 – Applications for Reader 2007 module**

## **2.3 Description of the modules**

### **2.3.1 Productivity 2007**

The user opens a file, searching the document for a keyword. The user continues the search in an e-mail application. The user sends a new e-mail. The user opens spreadsheets to perform iterative data analysis. While performing this analysis, documents and email data are compressed into a single file. Opening a presentation, the user imports slides from another presentation along with a spreadsheet. Returning to the spreadsheet, the user organizes the data and formats the data for readability. The user opens a project management tool, performing data management tasks before creating a web format based copy of the schedule.

The user opens a presentation for direction on production of a web based interactive training tool. The user edits a variety of images, in bitmap and vector graphics formats, making visual quality changes, resizing and saving to new formats for use in the training material. While the user creates a PDF file of a group of images, an image is converted from bitmap to vector graphics format. The user completes the training tool by importing the edited images, as well as previously created audio and video clips. The user publishes the resulting tool in a web compatible format. This process is repeated until the battery is depleted.

### **2.3.2 DVD 2007**

The DVD module plays a video DVD that BAPCo has created from the open-source 3D animated short film, *Elephants Dream* ([www.elephantsdream.org](http://www.elephantsdream.org)). In this test, the user starts the movie player application, sets up a full-screen playback, and then plays the two-hour movie on the DVD. Once the movie ends, it repeats indefinitely until the battery is depleted.

### **2.3.3 Reader 2007**

The user opens an Adobe Acrobat document (PDF) with the intent of detailed reading of its contents. The document opened (which happens to be white papers for previous versions of BAPCo products) contains approximately 50 pages of rich, technical content. The user takes two minutes on each document until reaching the end. At that point the document is closed and the next document (which happens to be the same content) is opened. This process is repeated until the battery is depleted.

## 2.4 Constructing the Workload

BAPCo found general behavioral trends that were common to many usage categories. When constructing the workloads, these characteristics were included to make the workloads more realistic.

BAPCo identified a few general trends that govern how users interact with a portable computer. When constructing the workloads, these characteristics were included to make the workloads more realistic:

**Switching Between Applications:** Users of mobile PCs frequently keep several applications open on their screen at the same time. For example, a mobile professional often has many components of Office 2003 (Word, Excel and PowerPoint) open at the same time and switches back and forth between these Office components. Thus, the workloads defined by BAPCo include opening and leaving applications open while work is being done in another application.

**Concurrent Execution:** In addition to switching between applications, it was observed that often a user would be actively working with one application while another application was performing work in the background. For example, a mobile professional user could have file compression applications executing in the background while Office documents are being created in the foreground.

**User Away Time:** Users of mobile PCs often leave their systems idle for a period of time between sessions of active use. In the Productivity module, MobileMark 2007 simulates this behavior by performing a small series of operations, then allowing the system to sit idle for a while before the next task.

Inclusion of these idle periods better models real-world mobile usage and allows the benchmark to put the power management features of the notebook to full use. Additionally, the operating system may take advantage of the resources of the inactive system by performing in the background virtual memory management, defragmentation, or other optimization activities.

## **2.5 Automation and Workload Integration**

The final step in creating MobileMark 2007 is translating the workload into an automated benchmark. MobileMark 2007 emulates a person interacting with the computer through the use of deterministic delays and paced input. These emulated commands are converted into scripts that are used by the benchmark to control each of the individual applications included in MobileMark 2007. In order to make sure the benchmark is deterministic, BAPCo uses a framework to install applications, run the scripts, and record and display the performance results. For screen shots of the applications running through the framework see Appendix B. The measurement methodology used by the framework is shown below.

### **2.5.1 Measurement Methodology**

The primary measurements of MobileMark 2007 reflect battery life. A secondary performance rating is reported for the Productivity module to qualify the battery life rating. Performance is measured in a method similar to that used by SYSmark individual operations are timed, aggregated, and compared against a standardized system. Battery life (measured in minutes) is computed by running the entire workload repeatedly until the battery is depleted.

At the start of a test, while the computer is still plugged in to wall power, the benchmark performs a system optimization step that aims to minimize the incidence of non-deterministic operating system activity during testing. This helps to ensure that test results are reliable and repeatable.

Upon completion of the system optimizations, the user is instructed to unplug the computer from wall power. The program then starts the workload scripts.

The DVD and Reader modules simply repeat their workloads until battery power is depleted.

The Productivity module is somewhat more complex. One cycle of this workload is completed every two hours. There is a fixed amount of work that takes place within that period of time, with the balance of the time taken by fixed-length and variable-length user delays distributed throughout the workload to simulate user “away” or “think” time. The variable-length pauses ensure that a faster system and a slower system will do the same amount of work in a given amount of time. This two-hour cycle is repeated until the battery is depleted.

When testing the Productivity module, the system battery must last long enough to allow the first workload cycle to finish performing its measured operations; otherwise ratings cannot be produced for the system. Generally, all performance measurements will be complete approximately 110 minutes into testing. A final pause will round out the 120-minute cycle, which will then be followed by the next workload cycle.

MobileMark monitors the state of the machine while the battery is draining, and checks for certain conditions that might invalidate the test (such as the power cord being plugged in during the test run).

Operating system and application behavior is more realistic in MobileMark because the user modeled delays enable the operating system and applications to perform normal housekeeping activities. For example, while applications schedule spell checking and grammar checking, the operating system can also execute idle time activities. Think time avoids unnatural compression of operating system page use information, which can

make memory management algorithms in the OS less effective. The addition of "think time" also enhances cross-platform stability.

### **2.5.2 Battery life rating methodology**

The benchmark generates battery life ratings as its principal metric.

The battery life rating in MobileMark 2007 is measured in minutes. This metric reflects the number of minutes the system can remain operational while executing a chosen module. Each module will produce a different battery life rating, reflecting differences in system loading.

The battery life is established by recording the start time of the benchmark, then repeatedly performing the workload. When the remaining battery capacity has fallen to 7% the benchmark records a timestamp once per minute. Once the battery has been depleted and the computer plugged in and rebooted, the benchmark compares the "start" timestamp and last recorded ("end") timestamp. The battery life rating is the number of minutes between these timestamps.

Note that when the battery falls to 7% remaining capacity, the system hard drive will not be allowed to "spin down" because the benchmark must periodically write to the disk. This causes a slight increase to system power draw. This necessary benchmark overhead is mitigated in two ways:

1. This activity occurs only during the last 7% of the benchmark run.
2. During testing, it is often the case that the hard drive is already active due to workload activity.

### **2.5.3 Battery life considerations**

The primary metric of the MobileMark usage models is battery life. Battery life as measured by MobileMark is defined as the amount of time the system can execute given workload, starting from a 100% charged battery state to the point at which battery depletion causes the computer to power down.

Individual manufacturers may design their computers to turn off before the battery is fully depleted in order to assure the battery has enough charge to allow the operating system to save all data before the battery fails to operate. Such features, when enabled, can reduce the battery life rating reported by MobileMark. This rating, therefore, reflects the reduced battery life that a user would see with such features enabled.

In order for MobileMark to produce a battery life rating, a computer must endure at least one minute of testing after the remaining battery capacity has fallen to 7% in order to ensure that an "end" timestamp is recorded. If, for example, a computer is designed to shut down as soon as the battery reaches 10%, the "end" timestamp will never be recorded and MobileMark will be unable to produce ratings. Such a setting will result in MobileMark being unable to produce a score.

Batteries that have been used frequently or stored inactive for long periods of time can report their remaining capacity incorrectly. Such batteries will often fail (causing the computer to power down) while reporting significant remaining capacity, causing MobileMark test failures or sub-optimal battery life ratings. For best practices using MobileMark 2007, please refer to the MobileMark 2007 run rules.

#### **2.5.4 Performance rating methodology**

The performance rating given by the Productivity module is a qualifier for the battery life rating. This is a secondary metric in MobileMark.

As there are several ways to design a notebook, the performance qualifier is intending to show the user the trade-off between battery life and performance.

Each module is a tool designed for specific purposes. The DVD playback module reports the battery life when performing DVD playback. A medium activity level when run at low performance levels which includes optical drive operation. Reader reports the battery life while reading a document within a document reader. This module is expected to be representative of the peak system battery life use model. The Productivity module is designed to measure the system balance point battery life in business user scenario where performance matters. Because MobileMark is focused on the power performance trade-off it does not reveal the full performance potential of the system. To best quantify this we recommend BAPCO's SYSmark product.

The performance rating is representative of "response time". Response time, in the context of the Productivity module, is defined as the time it takes the computer to complete a task that has been initiated by the automated script. The task can be initiated by a mouse click or a keystroke from the keyboard. For example, the response time for a Replace All command in Word 2003 is the time between clicking the Replace All button in the Edit/Replace window and the time that Word 2003 brings up the completion window. In MobileMark 2007, only the response time of individual operations is included in the performance metric; MobileMark 2007 ignores the time to send keystrokes and mouse clicks to the application. In the real world, these tasks are initiated and controlled by a human and therefore do not measure computer performance. Since these tasks don't measure computer performance, they are not timed.

The performance rating is based on the average response time for the system being tested compared to that of a fixed reference platform. A rating of 200 indicates the test system has a MobileMark 2007 performance equal to that of the reference platform using MobileMark 2007. A rating of 400 indicates the test system has twice the MobileMark 2007 performance of the reference platform, completing the same tasks in half the time. The MobileMark 2007 reference platform's configuration is listed in Appendix C.

When using a metric, such as MobileMark's performance rating, to qualify a battery life rating, it is relevant to understand the operations and applications involved and their relevance to the score in the form of their distribution. Note that while different platforms will produce different application performance distributions (as well as differing power expressions from those workloads) the reference platform remains an appropriate basis for discussion and understanding the performance scoring.

The applications for the Productivity module are shown in Appendix A and the reference platform is described in Appendix C.

The following graphs & tables of the performance qualification that shows the distribution of measured application task times on the reference platform that create the baseline rating of 200. The following graphs and tables do not reflect battery-life usage or scoring. Distribution of application contributions are specific to the reference platform and will vary from system to system.

Adobe Flash Creation	33.6%
Adobe Photoshop CS2	21.8%
Adobe Illustrator CS2	16.7%
Microsoft Excel	16.6%
Winzip 10.0	7.1%
Microsoft Word	1.1%
Microsoft PowerPoint	1.0%
Microsoft MS Project	1.2%
Microsoft Outlook	1.0%

Table 4 - Application Contribution to Reference Score

The chart below shows the complete distribution of measured operations which together compose the base reference score. Understanding the distribution of these operations allows an understanding of how MobileMark measures performance while creating a standardized system power battery load. Distribution of application contributions shown are specific to the reference system and will vary from system to system.

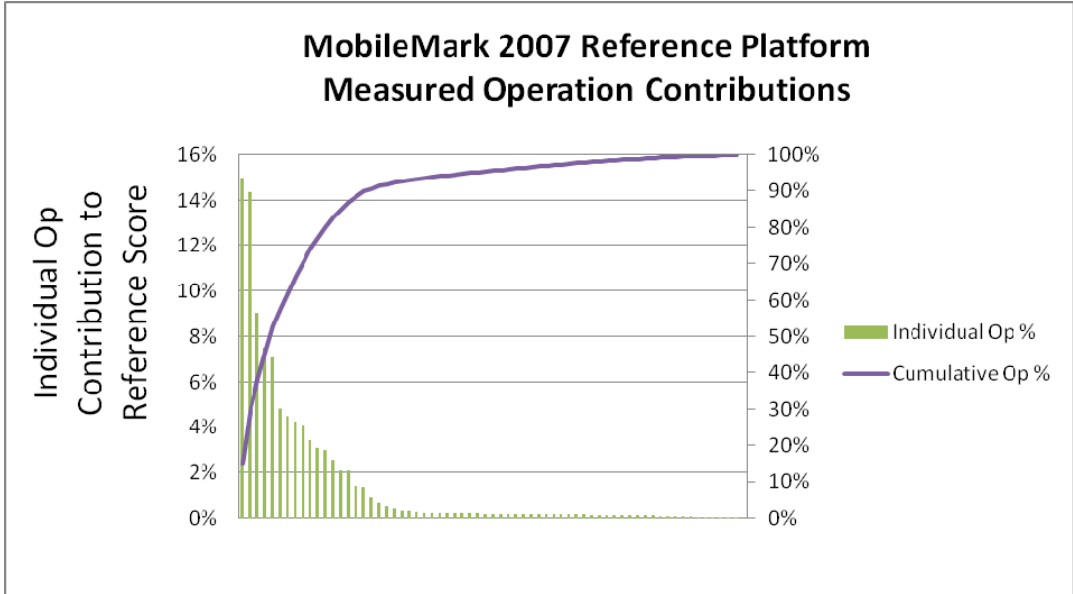


Table 5 – Complete graph of measured application contributions to the Calibration Reference Score

The chart below shows an excerpt of the top contributors to the base calibration score.

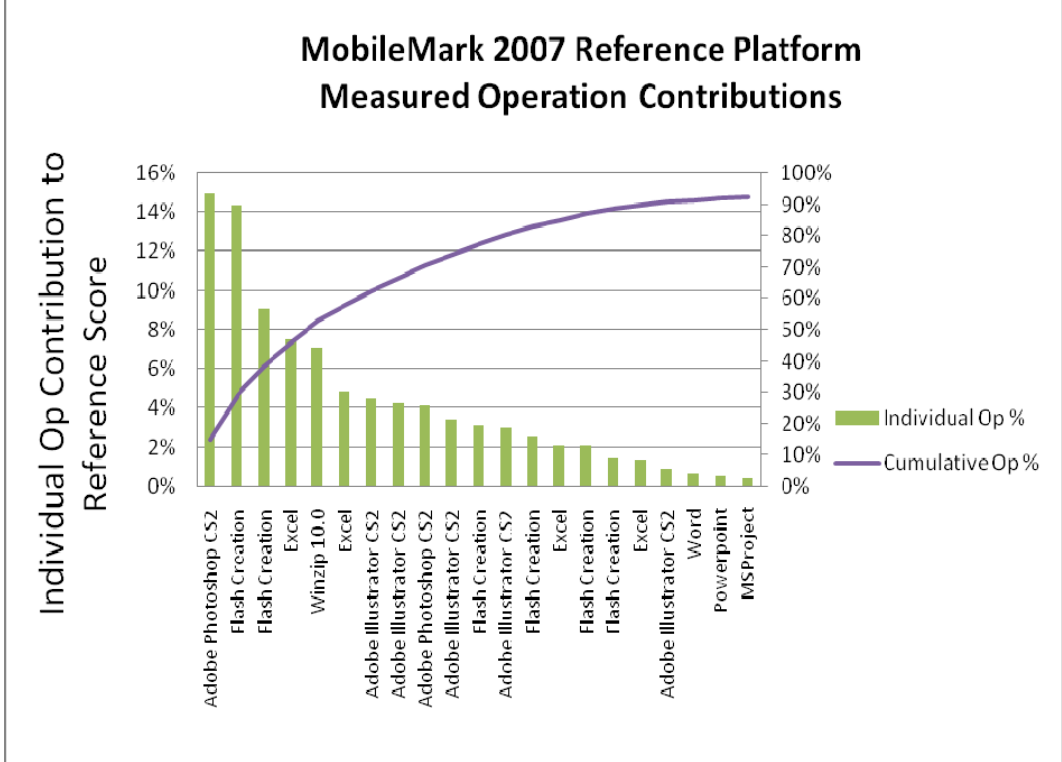


Table 6 – Partial graph of measured application contributions to the Calibration Reference score, showing the largest contributors

### 3.0 MobileMark 2007 Scoring Methodology

All scenarios report battery life ratings. The Productivity module additionally reports a performance qualification.

#### **Productivity 2007: Battery life rating**

Reports the duration, in minutes, observed while performing a representative session of mobile office productivity tasks.

#### **Productivity 2007: Performance**

Reports a performance qualification based upon the average response time for the system being tested relative to the reference platform rating of 200. Only measurements taken during the first iteration of the module are used in calculating the rating. The rating is calculated by dividing sum of these measurements on the reference system by the sum of these measurements on the system under test, multiplying by 200, and rounding to the nearest integer.

A rating of 200 indicates performance on par with the reference system. A rating of 100 indicates that the tested system took twice as long, on average, to perform tasks as the reference system. A rating of 400 indicates that the tested system took half the time, on average, to perform tasks as the reference system.

#### **DVD 2007: Battery Life**

Reports the duration, in minutes, observed while watching a DVD movie.

#### **Reader 2007: Battery Life**

Reports the duration, in minutes, observed while reading an electronic document. This duration is intended to represent the longest battery life one could expect while executing a typical usage scenario.

There is no MobileMark 2007 “overall” rating, as each class of system implementation has different goals and an overall definitive rating would be misleading.

## 4.0 Features & Characteristics

Originally, portable PC systems were exactly that, a portable version of a desktop system. Compaq's introduction of the original "luggable" PC in 1982 is a prime example, where all components required to implement a desktop system were bundled into a single box, with a single handle, for a single purpose: portability. Since then, increased integration, manufacturing techniques, detailed power management, and battery technology have improved, and driven portable designs to become fully disconnected from the power socket leading to what is now referred to as mobility. This unplugged nature has now extended to mobility and connectedness; with the advent of wireless technologies this definition has been extended to include connectivity.

The march towards what has become very specialized design, with very different design goals than their desktop brethren, has progressed to a point where selecting a mobile system is more than just finding which system runs fastest. It is also more complicated than just size and weight. The target markets for these systems, such as desktop replacement, thin and light, or budget provide for widely varied vendor differentiation. The shape of the physical envelope, the resolution of the display screen, the battery size, capacity, and weight, and other features are considered in specifying a system. To further complicate the issue, mobile systems now feature full and unique system designs that implement specialized chipsets and additional features not found in desktops. These features can allow the designer to make trade offs such as adjusting CPU clock speed to moderate power use and heat generation, implement temporary sleep states to reduce power while balancing responsiveness, and power off components such as disk drives when they are not being used. The primary module in MobileMark 2007, Mobile Productivity measures the net result of these implementations as battery life, while providing insight into the design tradeoffs with the performance response rating.

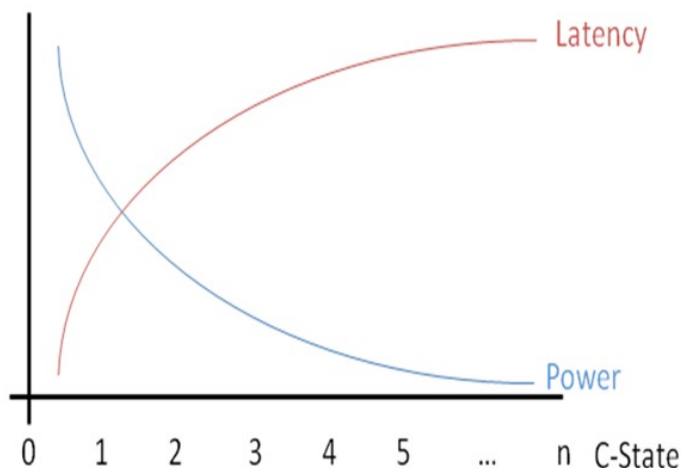


Figure 1: Example of power and latency change in different C-States

There are two general strategies used to adjust system performance to extend battery life and reduce heat: C-State (CPU) manipulation and P-State (performance) manipulation. C-State manipulations are managed by OS policy, while P-State manipulations are usually managed by an OS driver working hand-in-hand with a BIOS implementation.

The term C-State is used to describe a "CPU" state. The fully operational state is C0, where all components are fully powered-on and active, and the response is identical to a similarly configured desktop system. If the system is momentarily idle (waiting for a user to enter a key,

for instance), the system can drop to a lower power state, such as C1. The trick is that it takes a finite time to go from C0 to C1, and another finite period to return from C1 to C0. If the system is still idle after some brief interval (as determined by the operating system), the system can continue to drop to lower power states such as C2 or C3, thus saving further power. The tradeoff is that the system requires more time to return to the fully operational C0 State the deeper it drops into power-saving states. The battery efficiency a system designer creates is balanced by the recovery time. In an ideal implementation, the designer adjusts the ups and downs of the C-State transitions to maximize battery life while still providing optimum responsiveness. MobileMark 2007 helps to quantify that implementation with the performance responsive rating.

The term P-State is used to describe a CPU's "performance" state. Using a combination of frequency and voltage controls, the CPU is run at full speed and power, minimal speed and power, or some combination between these two limits to provide different levels of performance. These levels of performance result in different heat generation and power consumption. Note that P-State manipulation is separate from C-State changes. As in C-States, though, it takes a finite period of time to transition from one P-State to another. In order to throttle up a CPU from its lowest setting (when the system is idle, or passively displaying a web page, for instance) to its highest setting (when the user begins to render their two hours of summer vacation movies into a DVD for all the family to enjoy, for instance) takes a finite time. Again, MobileMark 2007 helps to quantify the net effect of the P-State implementation with the battery life rating, while qualifying it with the performance response indicator.

Note that the system implementation, BIOS configuration, accessories, or specific uses of the system can also affect the C-States experienced by the user and their efficacy. For example, plugging in a USB device may prevent some systems from utilizing low-power states. Following consistent testing procedures as stated within the MobileMark run rules will assist in minimizing inconsistencies.

## **4.1 MobileMark Usability Features & Execution Improvements**

Compared to MobileMark 2005, MobileMark 2007 features improved error handling and support for Windows XP and Windows Vista. For details on the operation of these new enhancements please refer to the help documentation provided on the product DVD-ROM.

### **Support for Windows Vista:**

- MobileMark 2007 supports 32-bit versions of English, French, German and Japanese language installations of Windows Vista (all editions) and Windows XP (Home and Professional).

### **Fully Updated Workloads and Applications:**

- All workload modules have been updated with applications and user activities that reflect the activities of today's mobile users.

### **Automatic System Optimization:**

- System optimization, which necessitated a separate test run in MobileMark 2005, is now integrated into the test setup process in MobileMark 2007. The benchmark triggers operating system optimization activities in Windows XP and Vista, enabling users to obtain ratings with a high degree of confidence and repeatability. This step minimizes the impact of non-deterministic OS activity during testing in a way consistent with real-world usage.

### **Automated Generation of Error Reports:**

- In the event of a test failure, MobileMark 2007 now automatically captures an error report and saves all test-related information in a new folder on your desktop. This data can be sent to BAPCO to obtain technical support.

## 4.2 General Setting Requirements:

As a part of its license agreement, BAPCo requires that all licensees submit an FDR to BAPCo any time such licensees publish any results related to BAPCo (see <http://www.bapco.com/support/mobilemark2007/manual/fdr.html> for FDR submission rules)

The reason for these requirements is clear: all battery life or performance claims regarding BAPCo benchmarks must be repeatable and comparable when using the configurations listed in the FDR (see also, the "Benchmarking Rules" section of the help file of your specific benchmark for any other requirements for submitting FDRs).

When using MobileMark for private evaluation it is strongly recommended that the FDR requirements are followed so that any obtained results can be compared with those from other FDR sources as these rules act to ensure repeatable results.

In MobileMark 2007 there are a number of factors unique to notebook evaluation that should be noted.

### 4.2.1 Display brightness

The display panel luminance can greatly affect battery life, so BAPCo requires an instrumented approach for FDRs when setting display brightness (for further information please refer to <http://www.eblwg.org/index.asp>). The display brightness should be measured for a white screen while on battery and be set at the lowest possible setting, no lower than 60 nits. The 60 nit level was chosen as a reasonable "middle" setting, bright enough for the display to be viewed in a common office environment, but not too bright for a darkened room. An easy way to get a white screen is to open Microsoft Paint in a full screen mode using a blank document just prior to running the test.

In addition, the display brightness of a white screen must not drop lower than the initial setting during the test. This implies that all features lowering the brightness of a white screen must be disabled. Examples of these features are panels that lower overall brightness as the battery discharges and ambient light sensors.

If a luminance meter is not available it is not possible to submit an FDR. Furthermore, it is required that the nit level be disclosed when submitting an FDR. Note that a luminance meter, which measures nits, is not the same as a light meter, which measures lux.

### 4.2.2 Audio

Headphones or speakers provide an outlet for the audio load and must remain connected during the DVD module. The audio is to be adjusted so that it is comfortably audible through the headphones or speakers. Some noise cancelling headphones may carry a battery-life overhead and for this reason BAPCo does not recommend their use during MobileMark 2007 testing.

## 4.3 Considerations for DVD Module

For the development process of the DVD module, BAPCo experimented with a diverse selection of movies ranging from those with lots of action to ones with very little activity. The analysis showed that differing video decoding demands (such as action scenes vs. landscape scenes) did not significantly affect battery life. Further investigation into a wider range of movie categories such as those with cartoon-like animation, those featuring rich floral landscapes, dark night-time movies and sunny musicals confirmed these same findings; the battery runtimes differed by only a few minutes.

The studio quality DVD provided with MobileMark 2007 falls within the same range of battery life as other studio produced content.

#### **4.4 Effect of Battery Degradation**

The total energy capacity of a battery degrades over time. Multiple charge and discharge cycles on a battery can result in a reduction of the total time that it can power a system and sustain user activity.

Our findings show that battery life on new systems is optimal but as systems age, the natural degradation of the physical battery reduces the battery life available to users. While these findings may not be seen immediately, and can vary from platform to platform over a period of a year, this effect can be demonstrated.

As systems age, other components in addition to the battery may also contribute to increased system leakage. For example, as screens age, their luminosity declines. Users will compensate for this by increasing the screen brightness, which in turn, results in a higher power draw and a further reduction in available battery life.

While it is appropriate to compare older systems to new systems, it is important to note that newer electronic components normally offer advantages in power efficiency over older components of the same design.

It is recommended that a battery with low cycle count (above 3 and fewer than 20) be used if available. This can also be achieved with battery conditioning. If the battery exhausted whilst indicating over a 7% remaining capacity it will generate an error within MobileMark 2007. This could be indicative of a poorly performing battery such as one with a high cycle count (please contact your vendor for additional cycle count diagnostics). Notebook batteries are different to those purchased at a convenience store; they are considered sophisticated in that they learn from previous run-time activity in order to more accurately report remaining battery life.

## 5.0 Conclusion

MobileMark 2007 is the latest version of the premier notebook battery life benchmark, featuring all-new user-driven workloads and support for Microsoft Windows Vista\*. It is based on a foundation of extensive research into emerging usage models and computing trends and incorporates the latest benchmarking methodologies to evaluate platform technologies.

MobileMark 2007 contains scientifically designed workloads that represent the wide range of activities that a mobile worker may encounter. With extensive validation across multiple platforms, users can be sure of a consistent and reliable performance comparison.

As a result, MobileMark 2007 delivers a comprehensive array of test components in a unified structure that reflects the increasing diversity of notebook usage.

BAPCo's array of members represents the breadth of the computing industry. Over fifteen company representatives from BAPCo's membership in addition to numerous experts have collaborated over a two-year period so that MobileMark 2007 can build upon its predecessors through the utilization of the strongest and broadest development team in PC benchmark history.

These factors, amongst other numerous enhancements, affirm MobileMark 2007 as the premier notebook battery life metric and extend the BAPCo family of business benchmarks, which have been widely accepted by IT Managers, PC OEMs, media and analysts worldwide.

## ***APPENDIX A: Application Program Versions***

- Adobe<sup>®</sup> AcrobatReader 7.0
- Adobe<sup>®</sup> Illustrator<sup>®</sup> CS2
- Adobe<sup>®</sup> Photoshop<sup>®</sup> CS2
- Apple<sup>®</sup> Quicktime 7.1
- Intervideo<sup>®</sup> WinDVD<sup>®</sup> 8
- Macromedia<sup>®</sup> Flash 8
- Microsoft<sup>®</sup> Office<sup>®</sup> 2003 Pro
- Microsoft<sup>®</sup> Project 2003
- Winzip<sup>®</sup> 10.0

## APPENDIX B: MobileMark 2007 Screenshots

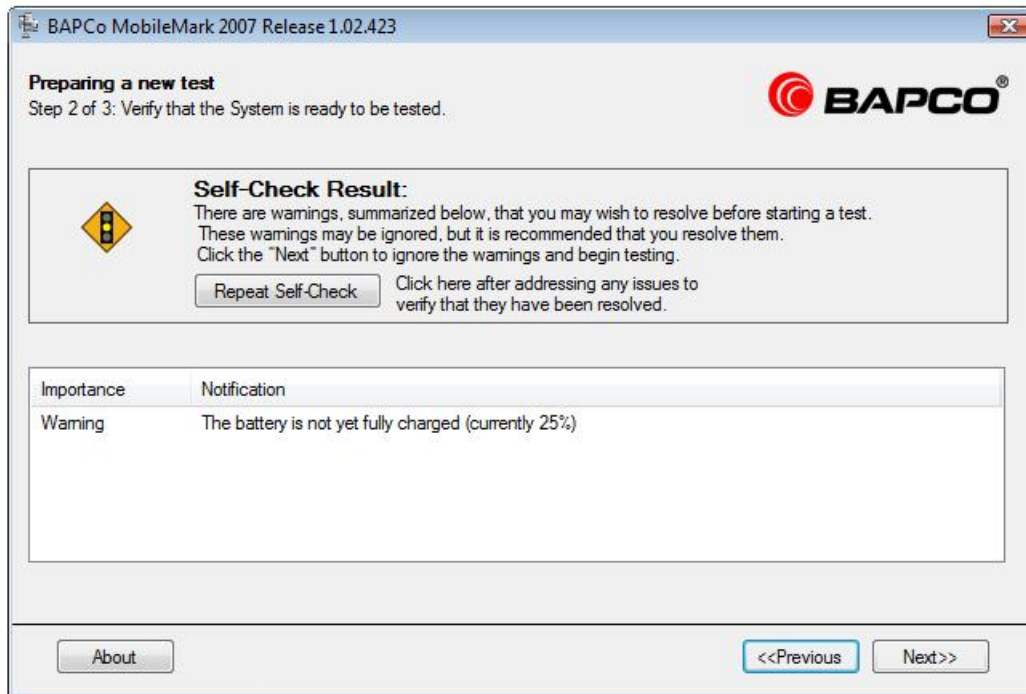
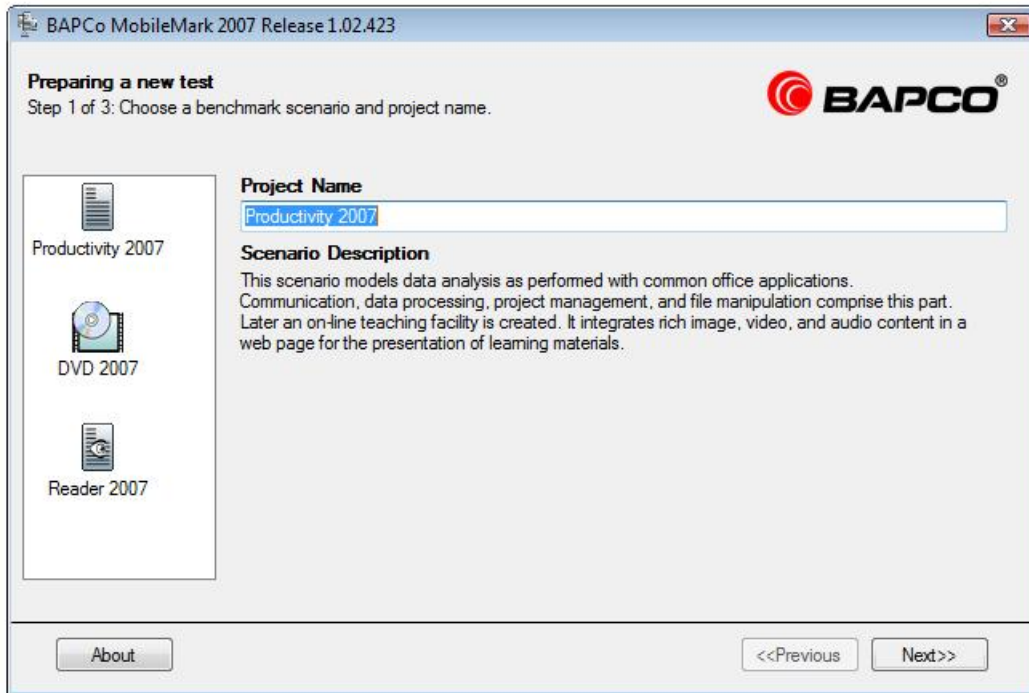


Figure 2: Screenshots from the MobileMark 2007 interface



Figure 3: Screenshot of the DVD module

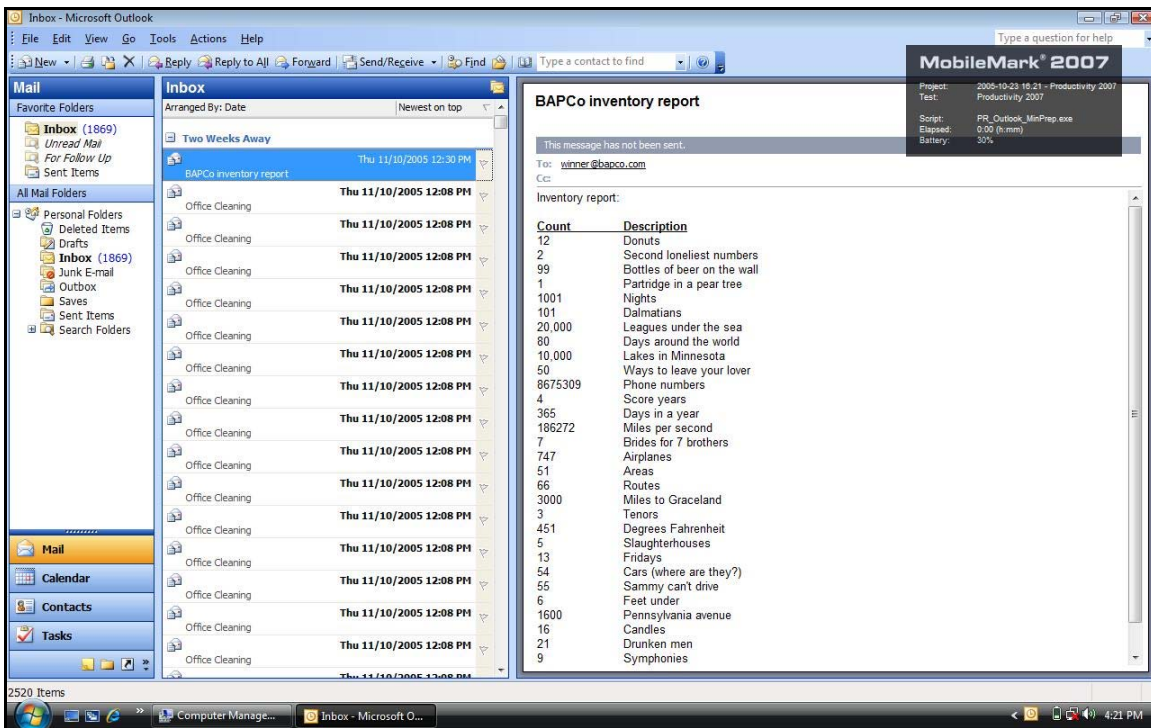


Figure 4: Screenshot of the Productivity module

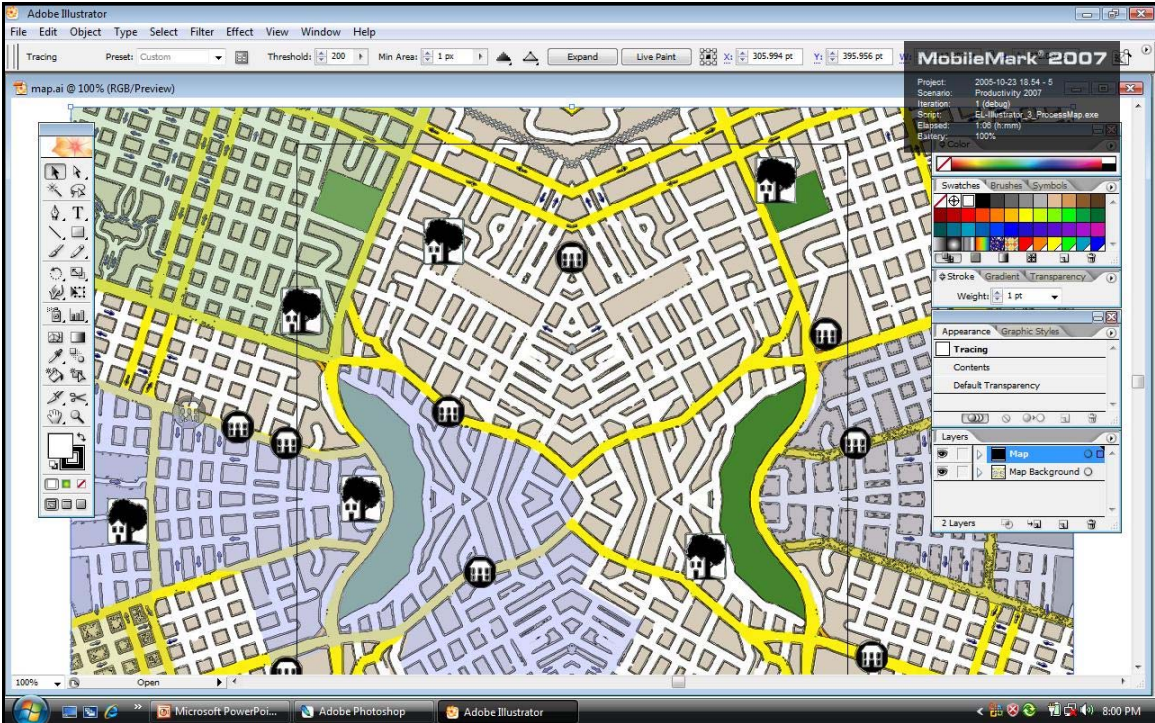
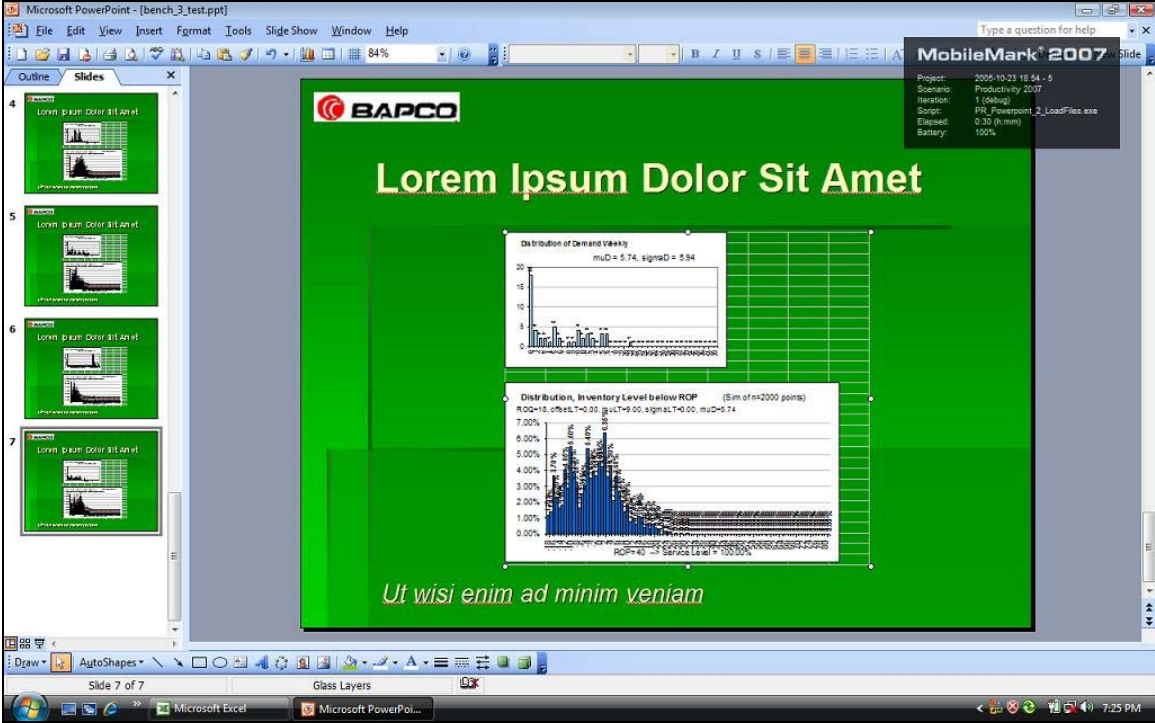


Figure 5: Screenshots of the Productivity module

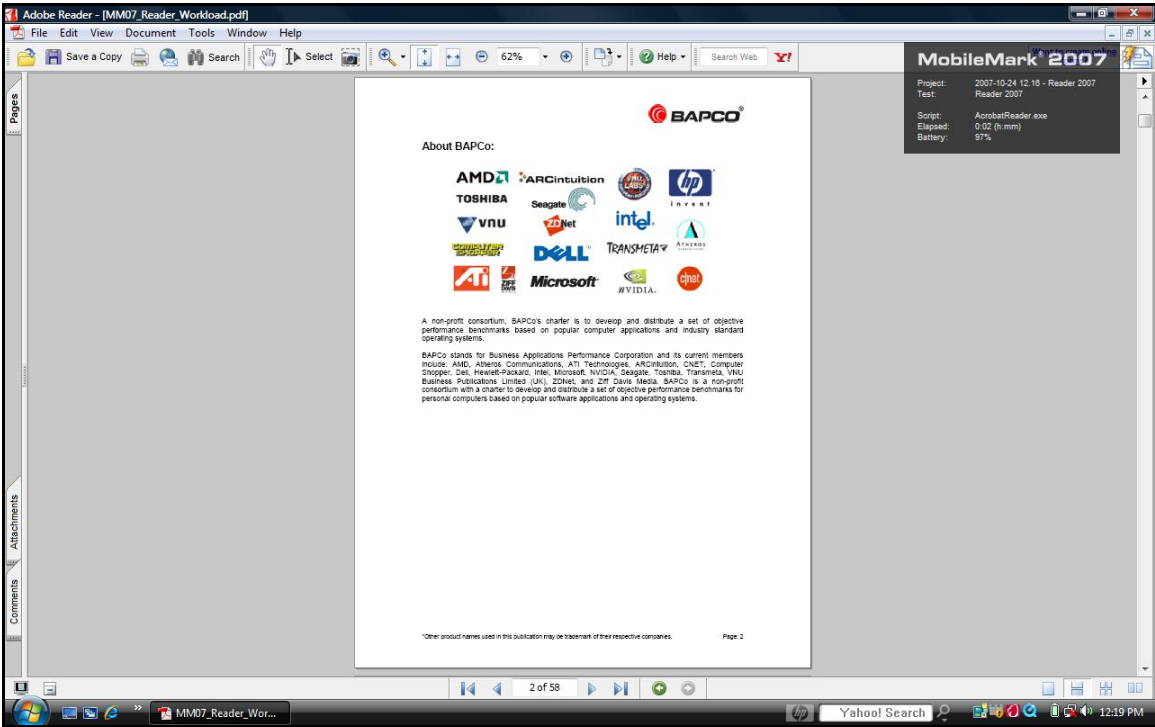


Figure 6: Screenshot of the Reader Module

\*Other product names used in this publication may be trademark of their respective companies.

## **APPENDIX C: System configuration for the calibration system for MobileMark 2007**

<b>System</b>	
Manufacturer	Lenovo
Model	T60 (2613CTO)
<b>BIOS</b>	
Version	79ETC9WW (2.09 )
Disk Interface	Change to AHCI after installing drivers.
<b>CPU</b>	
Manufacturer	Intel
Model	Mobile Core 2 Duo T7200
Speed	2.00 Ghz
Stepping	B2
<b>Motherboard</b>	
Manufacturer	Intel
Model	i945PM
Revision	03
BIOS Version	79ETC9WW (2.09) (12/22/2006)
BIOS Settings	Default
INF Version	7.2.2.1007 (Lenovo oss606ww)
Audio Driver	Lenovo 77a224ww
LAN Driver	XP Default
<b>Memory</b>	
Manufacturer	Samsung
Model	M470T2953CZ3
Type	DDR2 5300
Size	2 x 1 GB (2 GB total memory)
Speed	667 Mhz
Latency	5-5-5-15
<b>Video Card</b>	
Manufacturer	ATI
Model	Mobility Radeon x1400
Memory	512 MB
Driver	8.293.1.0
Revision	00
<b>Hard Drive</b>	
Manufacturer	Hitachi
Model	Travelstar HTS541010G9SA00
Size	100 GB
RPMS	5400
Cache	8 MB
Interface	SATA
Firmware	Unknown
Driver	Lenovo Matrix Storage 79im06ww

<b>Optical Drive</b>	
Manufacturer	Matshita
Model	UJDA775
Type	CD-RW/DVD
<b>Floppy Drive</b>	
None	
<b>Operating System</b>	
Manufacturer	Microsoft
Version	Windows XP Pro w/SP2 (32 bit)
Build	2600
Source	Clean install from CD
DirectX Version	9.0c
<b>OS Options</b>	
Display Resolution	1400x1050, 60 Hz
System Restore	Off
Windows Update	Off
Screen Saver	Off
Power Management	Lenovo Power Management
Software Version	Not installed
Driver Version	1.41
Mode	Laptop Portable
Wireless	Turned off at front panel