



MobileMark[®] 2012

An Overview of MobileMark 2012

April 2013
Revision 1.12

Revision History:

March 2012: Initial release
April 2012: Specified the minimum “dim” display brightness
April 2013: updated with MobileMark 2012 Lite product information

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About BAPCo

Business Applications Performance Corporation (BAPCo) is a non-profit member organization of companies in the computing industry. Its mission is to create a set of objective benchmarks for personal computers based on popular computer applications and industry standard operating systems.

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 behavior in widely used applications. BAPCo recognizes, however, that benchmarking intrinsically involves 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.

For more information about BAPCo or a complete list of the current membership, see our website at <http://www.bapco.com/>.

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1 Introduction

MobileMark® 2012 is the latest version of the premier performance-qualified battery life benchmark for notebook PCs. It features real world applications, updated workloads, support for Microsoft Windows® 7 64-bit and Microsoft Windows® 8 64 bit, and a new integrated system configuration tool that helps users perform required and recommended OS configuration steps.

MobileMark 2012 gives commercial and government IT decision makers, retailers, media, channel buyers, consultants, component designers, hardware designers, and manufacturers an objective, easy-to-use tool to evaluate the performance-qualified battery life of notebook PCs across the wide range of activities that a user may encounter.

MobileMark 2012 is designed for those who want to:

- Evaluate and compare notebook PCs for purchase consideration on the basis of performance-qualified battery life.
- Provide useful information to their audiences to assist in the evaluation and purchase of notebook PCs.
- Evaluate notebook PCs to better optimize their systems.

Unlike benchmarks that only measure battery life, MobileMark 2012 measures battery life and performance simultaneously, showing how well a system design addresses the inherent tradeoffs between performance and power management.

And unlike synthetic benchmarks, which artificially drive components to peak capacity or attempt to deduce performance using a static simulation of application behavior, MobileMark 2012 uses real applications, user workloads, and data sets in an effort to more closely reflect the battery life a user might expect when performing similar workloads.

MobileMark 2012 builds upon BAPCo's 20-year history of building benchmarks to evaluate platform technologies. Benchmarks designed by BAPCo are the result of cooperative development between companies representing the breadth of the computing industry. They harness a consortium of knowledge to better reflect the computing trends of today and tomorrow.

This document describes the methodologies employed in the development of MobileMark 2012. For detailed instructions on how to install and run MobileMark 2012 or MobileMark 2012 Lite, please refer to the documentation provided on the installation media and the BAPCo web site (www.bapco.com).

Since the original release of this document, BAPCo has released MobileMark 2012 v1.5 and MobileMark 2012 Lite. This document has been updated with technical information on these new MobileMark 2012 products.

MobileMark 2012 v1.5 added support for Microsoft Windows 8 64-bit operating system, bug fixes and application refreshes.

MobileMark 2012 Lite added support for Microsoft Windows 7 32-bit and Windows 8 32-bit operating systems, and bug fixes. This release uses 32-bit applications, and includes workload compatibility updates required for 32-bit operating system support.



Refer to the BAPCo 2012 product versions FAQ located in the MobileMark 2012 support section at www.bapco.com for more information.

1.1 What's New

For those who are upgrading from MobileMark 2007, here is an overview of the new features in MobileMark 2012:

New Scenarios

MobileMark 2012 includes three all-new scenarios. The Office Productivity scenario replaces the MobileMark 2007 Productivity scenario. New features include wireless network activity, more intensive business productivity workloads and expanded web browsing. The new Media Creation & Consumption scenario comprises professional and consumer media creation and consumption usage models. The Blu-ray Playback scenario updates the MobileMark 2007 DVD Playback scenario to reflect today's high definition video content.

Updated Applications

All of the applications have been updated to the newest versions available during development, and many of the workloads have been designed around new application features.

Integrated Configuration Manager

MobileMark 2012 contains an integrated BAPCo System Configuration tool that enables users to easily manage system configuration settings as recommended or required for correct benchmark operation, compliance with reporting requirements, and reproducibility of results.

Higher Display Brightness

Today's notebook PCs have brighter displays, and users expect battery technology to keep up. So MobileMark 2012 increases the minimum display brightness requirement to 150 nits. This helps ensure that MobileMark 2012 results more closely track user expectations for battery life.

Support for Display Dimming

MobileMark 2012 is designed to support hardware and OS mechanisms that dim the display when the user is away. Dimming, if enabled on the system under test, is permitted to occur in the Office Productivity and Media Creation & Consumption scenarios during periods of user idle time after a two-minute timeout.

Results Estimation

In MobileMark 2012, at the end of each scenario iteration, the estimated battery life and performance qualification rating are displayed in the Heads-Up Display to give you a preliminary indication of the results.

Support for Automation

MobileMark 2012 includes features to facilitate unattended installation, testing, and results analysis.

Improved Results Reporting

MobileMark 2012 produces test results in both human-readable (PDF) and machine-readable (XML) form. The human-readable results include a plot of the remaining battery capacity throughout testing, which helps testers identify battery anomalies. The machine-readable results are cryptographically signed, guaranteeing their authenticity.

2 BAPCo Development Process

BAPCo creates benchmarks in accordance with the BAPCo Development Process, a set of milestones and checkpoints collaboratively developed and agreed upon by the BAPCo membership.

Early in the process, prevailing business personal computer usage models are identified and grouped into scenarios according to their fit within a workflow. Applications are selected for each usage model on the basis of market research and technical feasibility.

BAPCo members then join together with expert application users in development sessions to collaboratively develop a workload specification for each scenario, defining each user/PC interaction which is to be simulated by the benchmark.

The goal of the development sessions is to produce representative business application workloads for the benchmark. Each application workload consists of three elements: the input data set, the tasks performed on the input data set, and the generated output. An example of generated output would be an image generated through an iterative process of steps to create a desired appearance. These three elements of the workload are chosen to represent the workflow of a user skilled in each given application.

After the workload specifications are created at the development sessions, BAPCo developers implement the workloads according to those specifications while satisfying benchmarking constraints to ensure the stability of the benchmark, the consistency of results, and the feasibility of implementation and distribution of the benchmark.

2.1 Milestone Overview

The BAPCo development process is divided into six major phases (Initialization, Design and Planning, Implementation, Validation, Characterization and Launch). Each phase consists of a series of milestones, some of which may be worked on concurrently.

The membership must vote to close each milestone. Once all the milestones within a phase are complete, the membership must vote to exit the phase and enter the next phase. BAPCo members work in a collaborative process where decisions regarding products are sometimes made by majority vote rather than unanimously.

The following is the list of the development phases and the corresponding milestones. Some of these milestones are explained in greater detail in the following sections, as noted in this list.

1. Initialization Phase
 - a. Milestone 0 – Committee kickoff
 - b. Milestone 1 – Benchmark market and customer analysis
 - c. Milestone 2 – Product positioning and customer value proposition
 - d. Milestone 3 – Preliminary marketing requirements document
 - e. Milestone 4 – Final marketing requirements document
2. Design and Planning Phase
 - a. Milestone 5 – Preliminary engineering requirements document
 - b. Milestone 6 – Usage model selection (*see section 2.2*)
 - c. Milestone 7 – Application selection (*see section 2.3*)
 - d. Milestone 8 – Define member resource commitments
 - e. Milestone 9 – Define development infrastructure
 - f. Milestone 10 – Define scoring methodology (*see section 2.4*)
 - g. Milestone 11 – Define application licensing requirements
 - h. Milestone 12 – Plan and execute workload development sessions (*see section 2.5, 2.6*)
 - i. Milestone 13 – Define product release criteria
 - j. Milestone 14 – Select product name
3. Implementation Phase
 - a. Milestone 15 – Create implementation schedule
 - b. Milestone 16 – Determine calibration system (*see section 2.7*)
 - c. Milestone 17 – Software development (*see section 2.8*)
4. Validation Phase
 - a. Milestone 18 – Validation testing
 - b. Milestone 19 – Define risk management plan
5. Characterization Phase
 - a. Milestone 20 – Characterization testing (*see section 2.9*)
 - b. Milestone 21 – Beta testing
6. Launch Phase
 - a. Milestone 22 – Product pricing
 - b. Milestone 23 – Pre-launch materials
 - c. Milestone 24 – Release to manufacture vote and sign-off
 - d. Milestone 25 – Duplicate and distribute media
 - e. Milestone 26 – Post-launch materials

2.2 Usage Model/Scenario Selection

In milestone 6 of the BAPCo Development Process, PC usage models are chosen for inclusion in a benchmark. For MobileMark 2012, BAPCo chose a wide variety of usage models on the basis of their relevance to a notebook PC user.

When choosing usage models for MobileMark 2012, BAPCo reviewed the usage models featured in other recent benchmarks, including SYSmark 2012 and EEcoMark Version 2, to identify which were relevant to notebook PCs. New usage models were also created specifically for MobileMark 2012.

After selecting usage models, BAPCo grouped related usage models into these three scenarios:

Office Productivity

The Office Productivity scenario models productivity usage including word processing, spreadsheet data manipulation, email creation/management, and web browsing. It also features wireless network activity.

Media Creation & Consumption

The Media Creation & Consumption scenario contains a mix of professional and consumer-oriented usage models. Included are professional photo manipulation and video encoding, as well as consumer photo management, video playback and audio playback.

Blu-ray* Playback

The Blu-ray Playback scenario consists entirely of Blu-ray Disc playback. The Blu-ray Playback workload disc contains a 91 minute of computer animated Blu-ray compliant movie. The video content is 1080p, encoded in H.264 with an average bitrate of 25 Mbps. The audio content is 5.1-channel, encoded in AC3 with an average bitrate of 640 Kbps. The 91-minute movie is played repeatedly until the battery dies.

Note: MobileMark 2012 Lite does not include the Blu-ray™ Playback scenario.

2.3 Application Selection

In milestone 7, after the usage models have been collected into scenarios, applications are chosen for the scenarios on the basis of market research and technical feasibility.

Sufficient lead time is needed after the applications are selected for BAPCo to develop workloads, integrate the applications into the benchmark, and perform validation of the benchmark. Therefore, in some cases the application versions may not be the newest available at the time of the launch of MobileMark 2012.

For MobileMark 2012, BAPCo has identified the following representative applications for the three usage scenarios:

Application	Version	Document Type
ABBYY® FineReader	Pro 11	Image files, word processing documents
Adobe® Acrobat®	Pro X	Portable document files, image files
Adobe® Flash® Player	11	Flash animations
Microsoft® Excel®	2010 SP1	Spreadsheets
Microsoft® Internet Explorer®	9 (see note 1)	Web pages
Microsoft® Outlook®	2010 SP1	E-mails
Microsoft® PowerPoint®	2010 SP1	Presentation files, image files, video files
Microsoft® Word	2010 SP1	Word processing documents
Mozilla® Firefox®	10.0.2	Web pages
WinZip®	Pro 16	Zip files, assorted document files

Table 1: Office Productivity Applications

¹If Internet Explorer 9 or newer is already installed on the system, MobileMark 2012 uses the version already installed.

Application	Version	Document Type
Adobe® Photoshop®	CS5 Extended 12.04	Image files
Adobe® Photoshop® Elements	10	Image files
Adobe® Premiere®	Pro CS 5.5	Video files
Microsoft® Windows Media Player	(see note 2)	Video files, audio files

Table 2: Media Creation & Consumption Applications

²MobileMark 2012 uses the version of Windows Media Player already installed on the system.

Application	Version	Document Type
CyberLink PowerDVD	Ultra 11	Blu-ray Disc™ content

Table 3: Blu-ray Playback Applications

A summary of the application versions installed and used by MobileMark 2012 products is included in Appendix A.

2.4 Scoring Methodology

In milestone 10, BAPCo decides the types of results that will be produced by a benchmark and the scoring methodology that determines how those results are calculated.

BAPCo determines the scoring methodology before determining the content of the workloads, which helps ensure that a methodology is chosen for its ability to generate results that correspond to user experience, not for the results it produces on a pre-determined set of workloads.

In MobileMark 2012, each scenario produces a battery life rating and some scenarios will also produce a performance rating. For scenarios which include a performance rating, the performance is given as a secondary result—a “performance qualification rating”—to the primary battery life rating.

MobileMark 2012 results are generated on a per-scenario basis, with each scenario requiring a separate run of the benchmark. Each scenario produces a battery life rating, and each scenario except Blu-ray Playback produces a performance qualification rating.

Scenario	Battery Life Rating	Performance Qualification Rating
Office Productivity	Yes	Yes
Media Creation & Consumption	Yes	Yes
Blu-ray Playback*	Yes	No

Table 4: Results Produced by Each Scenario

*Blu-ray Playback is not included in MobileMark 2012 Lite

Battery Life Rating

The battery life rating for a scenario is calculated by measuring the actual battery duration observed (from a fully charged state to a fully depleted state), in whole minutes, while running that scenario in repetition.

Performance Qualification Rating

MobileMark 2012 measures system performance by measuring the response times of tasks on a PC using real applications and simulated user input. Task response times are used to generate a performance qualification rating for a scenario that reflects the user experience. The faster a PC responds to the application workloads in MobileMark 2012, the higher its performance qualification rating will be. For more information on how task response times are measured, see section 2.8.

The performance qualification rating is given in relative terms, with respect to a calibration system. It is calibrated in such a way that a PC with performance equivalent to this calibration system for a given scenario will have a performance qualification rating of 100. A system twice

as fast as the calibration system on a given scenario (or, equivalently, that responds in half the time on average) will have a performance qualification rating of 200.

Performance qualification ratings are given for each successfully completed scenario iteration and for the scenario overall.

Calculation of the Performance Qualification Rating

A performance qualification rating p_i is first calculated for each successfully completed iteration of a scenario (excluding any conditioning iteration and partial iterations):

$$p_i = 100 \left(\frac{s_c}{s_t} \right)$$

Where:

s_c is the sum of the response times of tasks in that iteration as performed on the calibration system, explained below.

s_t is the sum of the response times of tasks in that iteration as performed on the test system.

The calibration sum s_c is a fixed value BAPCo calculates by performing three runs of the scenario—each including a conditioning run—on a calibration system (see section 2.7). For each successfully completed iteration among all three runs (excluding any conditioning iterations and partial iterations), the sum is taken of the response times of all the tasks in that iteration. s_c is the arithmetic mean of all those iteration sums.

p_i is rounded to the nearest 1/100th. For display purposes only, this is further rounded to the nearest integer.

Then the performance qualification rating for the scenario p_s is calculated by taking the arithmetic mean of the performance qualification ratings p_i for all successfully completed scenario iterations $i = 1, \dots, n$:

$$p_s = \frac{1}{n} \sum_{i=1}^n p_i$$

p_s is rounded to the nearest integer.

Results Estimation

During testing, once one full scenario iteration has completed, projected battery life and performance qualification ratings are calculated and displayed in the heads-up display. These values are rough estimates, reflecting the system behavior in the scenario iterations completed up to that point, and subject to the accuracy of the test system's battery level reporting mechanism.

The battery life rating estimate b_e is calculated using the following formula:

$$b_e = \frac{t(c_t)}{c_t - c_n}$$

Where:

t is the elapsed time since the test was started, in minutes.

c_t is the level of charge the battery reports having the capability to hold when fully charged, in any units as reported by the battery (typically amp-hours or watt-hours).

c_n is the level of charge reported by the battery presently, in the same units as c_t .

The performance qualification rating estimate is calculated by taking the arithmetic mean of the performance qualification ratings of all completed scenario iterations.

2.5 Workload Development

Once the usage models, scenarios, applications, and scoring methodology for the benchmark are decided, BAPCo members and application experts meet to create the application workloads that will be used in the benchmark.

The workload development sessions for MobileMark 2012 consisted of one week of face-to-face meetings that included representatives from BAPCo member companies and expert application users who had professional experience with the applications chosen for the benchmark. The application experts included professionals in the fields of web development, graphic design, and video editing. MobileMark 2012 also drew upon past workload development sessions involving professionals in the fields of small business marketing, information technology, and financial forecasting.

In these workload development sessions, the experts take the lead, weaving the usage models supplied by BAPCo into a storyboard of user interactions with a series of applications. Each user/PC interaction is written down in a workload specification, the specification used to automate the workloads later.

At the end of the workload development sessions, BAPCo comes away with a detailed workload specification for each of the benchmark scenarios and all of the input data sets needed to reproduce the workloads created at the sessions.

Additional Workload Considerations

The following additional factors come into consideration at the workload development sessions:

Input Data Set

Frequently in the sessions, the experts need raw digital content to serve as an input data set for a workload. Examples of such content might include a video to transcode, a presentation to modify, or documents to compress. When experts need such content, care is taken to ensure that they use something that is functionally representative of content they might use or encounter professionally.

For instance, if pictures are needed in order to create a web photo gallery, an expert might walk outside and take pictures using the same equipment he uses professionally. If an animation is needed for a web page that is to be browsed, an expert might purchase a stock animation from his usual online resource. Like the user interactions, all of these source materials are captured at the development session and used later in the development of automated workloads.

Task Switching and Concurrent Execution

In some cases, experts switch between open applications (e.g., as a user might between an e-mail program, word processor, and spreadsheet) or leave activities running in the background as they perform work in another application (e.g., as a user might leave a compression task to run in the background while browsing the web).

In MobileMark 2012, the Office Productivity scenario makes use of task switching and concurrent execution. Additionally, the Media Creation & Consumption scenario features background music playback during a portion of its workload.

2.6 Scenario Workload Descriptions

The workloads contained in each scenario are described below:

Office Productivity

Read, create, and search for emails. Create and execute a rule on email inbox. Use multiple browsers to browse a blog, online shopping site, wiki site, and social networking site. Check web mail in a private browser session. Combine multiple scanned pages from a complex document into an encrypted PDF document. Create a PDF with fillable form fields from scanned pages. Archive a diverse set of files into a single encrypted file. Use an advanced optical character recognition (OCR) program to convert scanned pages of complex and simple documents into editable word documents. Create a blog post and do a mail merge. Use a spreadsheet program to do data analysis. Create and view complex presentations that include clip art and video. Browse a variety of web pages which feature heavy media content, including video, HTML 5, CSS 3, and Flash content.

Some of these activities are performed concurrently to model typical multitasking behavior.

Throughout this workload, data is sent over a wireless network connection to model continuous background wireless network traffic.

Media Creation & Consumption

Play music in background while manipulating photos. Using a consumer photo application, automatically adjust and analyze a group of photos. Prepare some of the images for web use and generate a panoramic image. Stop the background music. Using a professional photo application, create a panoramic image using an image editing application, combine a set of photos into one high dynamic range (HDR) image, and adjust and prepare both images for print. Using a professional video editing application, combine images, video clips, and audio into a video, then encode the video to a web-ready format. Listen to music and watch a high definition video clip.

Blu-ray Playback

Play a feature-length Blu-ray-compliant 1080p movie from a Blu-ray Disc. When playback is complete, resume playback from the beginning. MobileMark 2012 Lite does not include the Blu-ray playback scenario

2.7 Calibration System

The calibration system is a system chosen in milestone 16 as a reference point for all MobileMark 2012 performance results. BAPCo chose the configuration below for its representation of a typical mainstream notebook PC at the time of release of MobileMark 2012.

The calibration system for all MobileMark 2012 products has the following configuration:

- **Notebook model:** Lenovo ThinkPad T420
- **BIOS:** 1.36 (Dated 10/31/2011)
- **CPU:** Intel Core i3-2350M Processor (2.30 GHz, 3MB L3)
- **Operating system:** Windows 7 Professional 64-bit Service Pack 1 (fresh OS installation with Lenovo drivers installed)
- **Operating system language:** US English
- **Display type:** 14.0" HD (1366 x 768) LED Backlit Anti-Glare Display, Mobile Broadband Ready
- **System graphics:** Intel HD Graphics 3000
- **System RAM:** 4 GB DDR3 1333 MHz (1 DIMM)
- **Keyboard:** US English
- **Camera:** 720p HD Camera
- **Hard drive:** Seagate ST9500420AS (500 GB, 7200 RPM)
- **Optical device:** DVD recordable multi-burner
- **System expansion slots:** Express Card Slot & 4 in 1 Card Reader
- **Battery:** 6 cell Li-Ion Battery – 55+ (57Wh)
- **Power cord:** North America Country Pack with Line cord & 65W AC adapter
- **Wireless LAN:** Integrated ThinkPad b/g/n WiFi
- **Mobile broadband:** Integrated Mobile Broadband (Upgradable)
- **Ports:** IEEE 1394a port
- **Language pack:** US English

Note: The calibration system does not include a Blu-Ray drive, but since the Blu-Ray Playback scenario does not have a performance qualification score, it is not necessary to calibrate the scenario.

For more details about the configuration of the calibration system, please contact support@bapco.com.

Please note that the minimum requirements to run MobileMark 2012 are listed in Appendix B and are not equivalent to the calibration system.

2.8 Benchmark Implementation

Once the workload specifications have been created, BAPCo begins the work of translating the workload specifications into an automated benchmark in milestone 17.

MobileMark 2012 is built upon scripts that do things in much the same way as a user would, using controls like buttons, text input boxes, and menus to navigate applications. See Appendix C for screenshots of the benchmark in action.

To ensure that MobileMark 2012 has deterministic behavior, BAPCo uses a framework to install applications, collect system information, run the scenario scripts, record performance measurements, calculate performance ratings, and display test results. The framework is kept lightweight, consuming a minimal amount of memory and compute resources, in order to ensure that battery life and performance measurements reflect the workload behavior and do not include overhead from the framework.

The fundamental performance unit upon which the MobileMark 2012 performance qualification rating is based is *response time*. Response time is defined as the time it takes the computer to complete a task that has been initiated by the automated script. A task can be initiated by a mouse click or a keystroke. The duration of each task is measured by the framework. Examples of tasks include launching an application, finding text in a document, copying a file, encoding a video, and performing an image manipulation.

The framework has several methods of detecting task completion, depending upon the method the application uses to signal task completion to the user. For example, the framework may wait for the application to show a completion message in the form of a pop-up window, or it may wait for a progress dialog to disappear and for control of the application to be returned to the user.

2.9 Workload Characterization

Once the scenario workloads are implemented and validated against the workload specifications created at the development sessions, BAPCo members then run the benchmark on a wide variety of systems to ensure that the benchmark produces results that are valid, representative, and reproducible.

During this process, BAPCo members share data, raise concerns, and suggest workload changes. Any workload change requires a majority vote of the committee.

MobileMark 2012 is primarily a tool for measuring battery life; therefore, it's important that the power profiles of its scenario workloads are reasonably representative of user experiences and expectations. BAPCo members work together to arrive at an estimation of a representative level of user activity, but acknowledge that individual user experience could vary from the results reported by the MobileMark 2012 scenarios.

The battery life reported by a MobileMark 2012 scenario is an approximation of the battery life a user who performs that same scenario workload would expect from the same system.

One way BAPCo members adjust the power profile of the workload is by determining an appropriate proportion of user idle time relative to active time.

User Idle Time

Users of notebook PCs often leave their systems idle for a period of time between sessions of active use. MobileMark 2012 simulates this behavior in the Office Productivity and Media Creation & Consumption scenarios by interspersing occasional periods of user inactivity throughout the workload.

Inclusion of these idle periods better models real-world mobile usage and allows the hardware and software power management features of the system under test to behave in a realistic manner.

MobileMark 2012 includes user idle time in the Office Productivity and Media Creation & Consumption scenarios in order to reflect the benefits of power-saving optimizations that are enabled by the power policy of the system under test and permitted by the MobileMark 2012 Benchmarking Rules. In order to provide a battery life metric that more closely aligns with user expectations of battery life, BAPCo chose not to model extended periods of user idle time (e.g., system standby) in MobileMark 2012.

Examples of permitted optimizations include display dimming, hard drive standby, CPU sleep, and wireless adapter power-saving mode, assuming such features are supported by the system under test and enabled in the system BIOS and OS power scheme.

Some power-saving optimizations are not permitted because of their relevance only in usage models featuring extended periods of user idle time. Examples of unpermitted optimizations include display standby, system standby, and system hibernation.

Current and Emerging Trends

During the development of MobileMark 2012, it was observed that web sites are making greater use of dynamic content such as Flash, HTML5, CSS3, and video. To reflect this trend, the web sites featured in the Office Productivity scenario were supplemented with more dynamic content and higher bitrate video.

It was also noted that although some applications support performing computations for certain workloads on the GPU, the output quality can vary dramatically from one GPU to another and even from one video driver to another. When BAPCo reviewed a candidate GPU-accelerated video encoding workload with Anand Lal Shimpi, editor-in-chief of hardware review website AnandTech*, he advised BAPCo against inclusion of such a workload on the basis that it would reward systems that sacrifice output quality in order to get the job done faster. Video application experts present at workload development sessions agreed, saying that quality and consistency of output were their top priorities.

Advances in display technology have made notebook PC displays brighter, and MobileMark 2012 acknowledges that trend by setting more aggressive requirements for display brightness in the MobileMark 2012 Benchmarking Rules. The rules require that the display brightness of the system under test must be set to a value not less than 150 nits.

And new in MobileMark 2012 is support for hardware- or OS-controlled dimming of the display when the user is not present. Dimming, if enabled on the system under test, is permitted to

occur in the Office Productivity and Media Creation & Consumption scenarios during periods of user idle time after a two-minute timeout. When dimmed, the display brightness must be no lower than 45 nits.

3 Workload Characteristics

This section provides data illustrating the characteristics of the workloads contained in MobileMark 2012.

3.1 Application Contribution Analysis

The following charts show the approximate contribution of each application to its corresponding scenario battery life rating on the MobileMark 2012 calibration system.

To calculate an application's contribution to a scenario battery life rating, the system power consumption is measured during a run of that scenario, and the energy consumption is aggregated for the time period when each application was in use. During periods of time where multiple applications are run concurrently, the power consumption for that time is attributed by dividing it equally among all of the active applications.

Due to system implementation differences, the charts in this section are accurate for the calibration system only. The contributions will vary from one system to the next.

3.1.1 Application Contribution to Office Productivity Battery Life Rating

The following chart shows the approximate contribution of each application to the MobileMark 2012 Office Productivity scenario battery life rating on the calibration system.

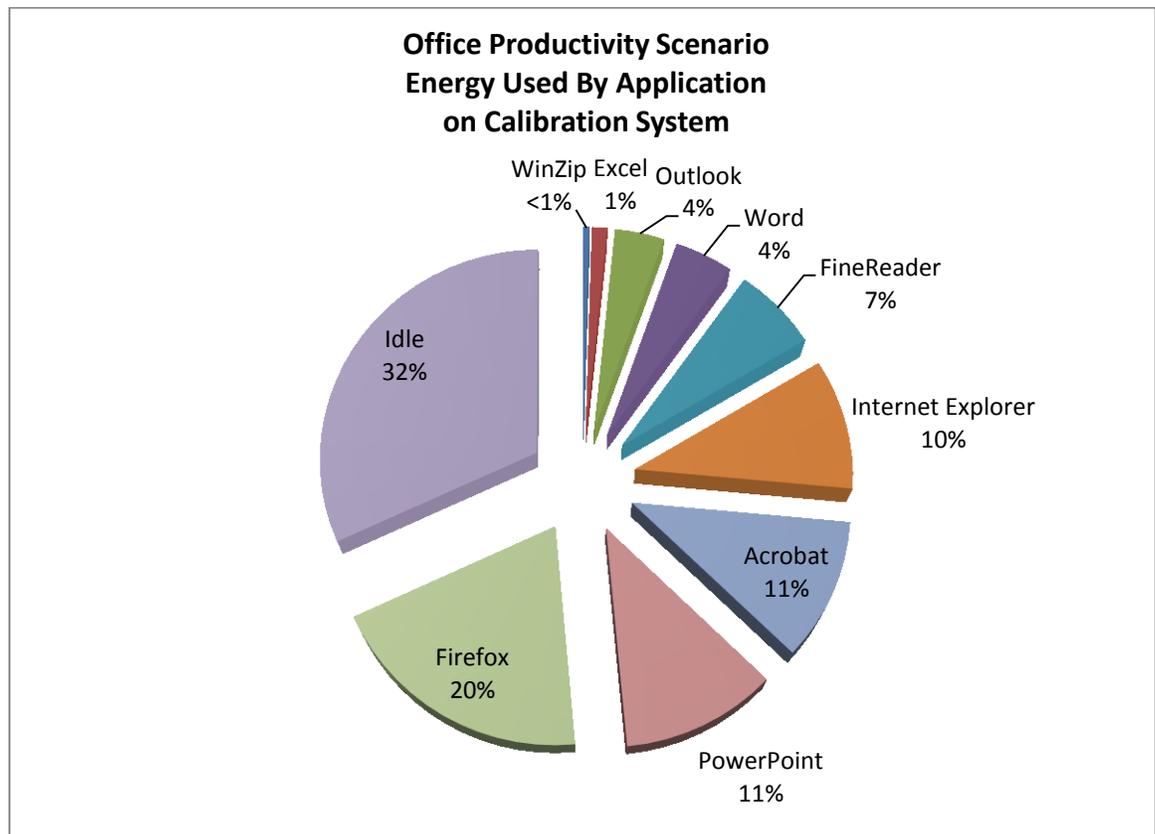


Figure 1: Approximate Application Contribution to Office Productivity Scenario Battery Life Rating on the MobileMark 2012 Calibration System (see section 2.7)

3.1.2 Application Contribution to Media Creation & Consumption Battery Life Rating

This chart shows the approximate contribution of each application to the MobileMark 2012 Media Creation & Consumption scenario battery life rating on the calibration system.

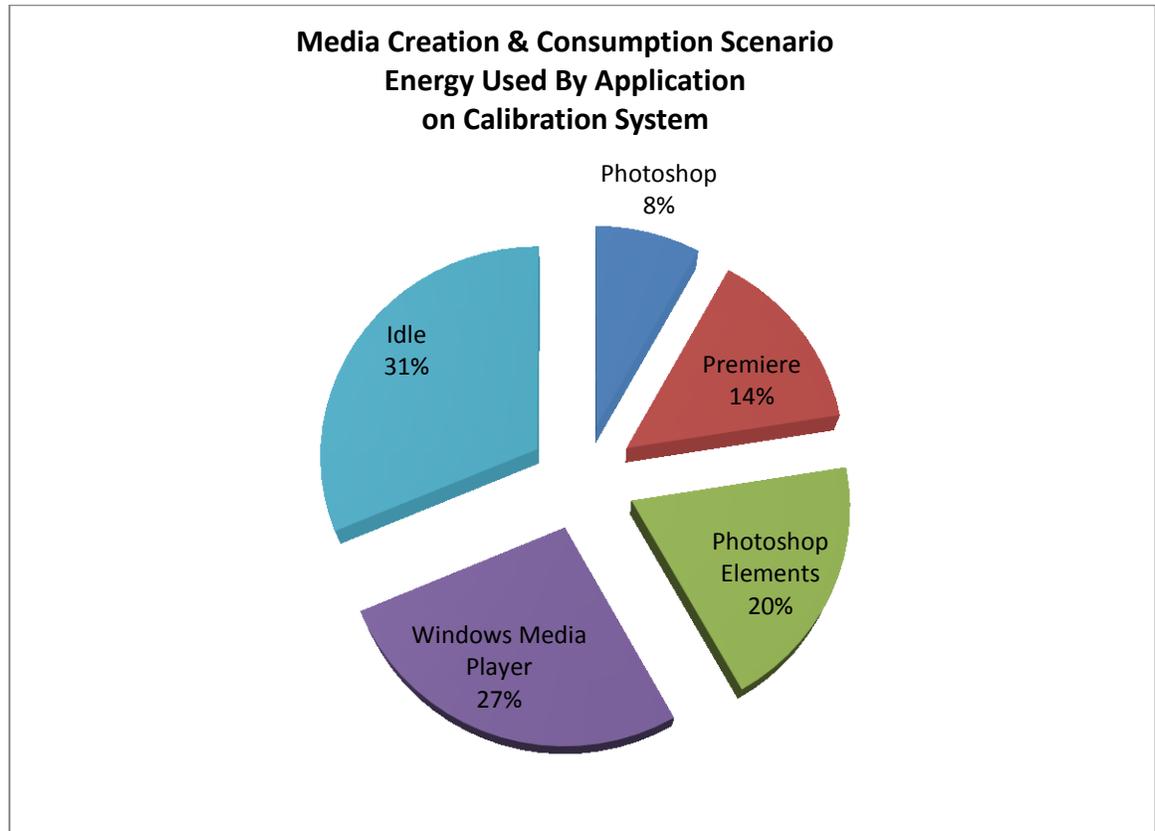


Figure 2: Approximate Application Contribution to Media Creation & Consumption Scenario Battery Life Rating on the MobileMark 2012 Calibration System (see section 2.7)

3.1.3 Application Contribution to Blu-ray Playback Battery Life Rating

The Blu-ray Playback scenario makes use of only one application, CyberLink PowerDVD, so no chart is included here.

3.2 Component Sensitivity Analysis

The following charts demonstrate the sensitivity of the MobileMark 2012 Office Productivity scenario to changes in individual hardware components.

These results were obtained using a system with the following base configuration:

- **Notebook model:** Lenovo ThinkPad T420
- **BIOS:** 1.37 (Dated 11/28/2011)
- **CPU:** Intel Core i3-2350M Processor (2.30 GHz, 3MB L3)
- **Operating system:** Windows 7 Professional 64-bit Service Pack 1 (fresh OS installation with Lenovo drivers installed)
- Operating system language: US English
- **Display type:** 14.0" HD (1366 x 768) LED Backlit Anti-Glare Display, Mobile Broadband Ready
- **System graphics:** Intel HD Graphics 3000
- **System RAM:** 4 GB DDR3 1333 MHz (1 DIMM)
- **Keyboard:** US English
- **Hard drive:** Hitachi HTS725032A9A364 (320 GB Hard Disk Drive, 7200 RPM)
- **Optical device:** DVD recordable multi-burner
- **Battery:** 6 cell Li-Ion Battery – 55+ (57Wh)
- **Wireless LAN:** Intel 6502 a/g/n WLAN

For the charts below, the following components were substituted as noted:

- System RAM:
 - 2 GB DDR3 1333 MHz (1 DIMM)
 - 4 GB DDR3 1333 MHz (1 DIMM)
 - 8 GB DDR3 1333 MHz (1 DIMM)
- CPU:
 - Intel Core i3-2350M Processor (Dual-Core, 2.3 GHz, 3 MB L3)
 - Intel Core i5-2520M Processor (Dual-Core, 2.5 GHz, 3 MB L3)
 - Intel Core i7-2620M Processor (Dual-Core, 2.7 GHz, 4 MB L3)
- Hard drive:
 - Hitachi HTS543225A7A384 (320 GB Hard Disk Drive, 5400 RPM)
 - Hitachi HTS725032A9A364 (320 GB Hard Disk Drive, 7200 RPM)
 - Samsung MZ7PA128HMCD-010L1 (128 GB Solid State Device)

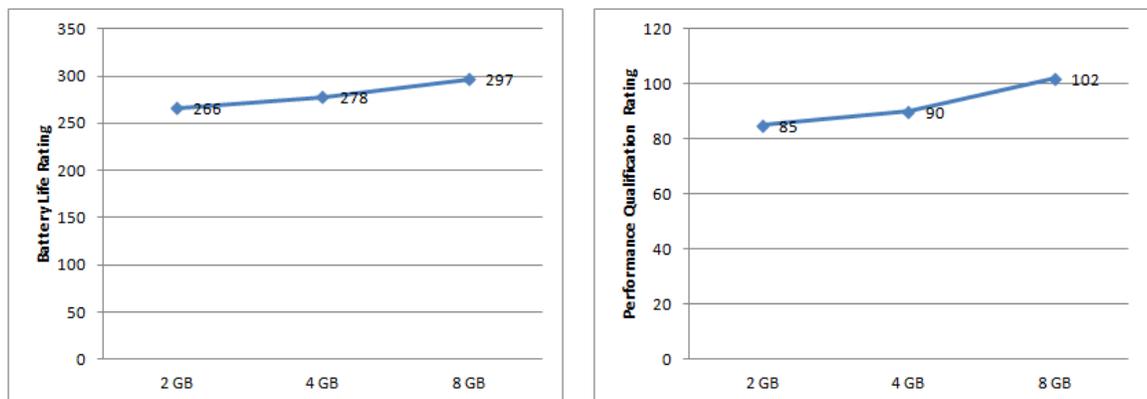


Figure 3: Sensitivity of Office Productivity scenario to different RAM configurations

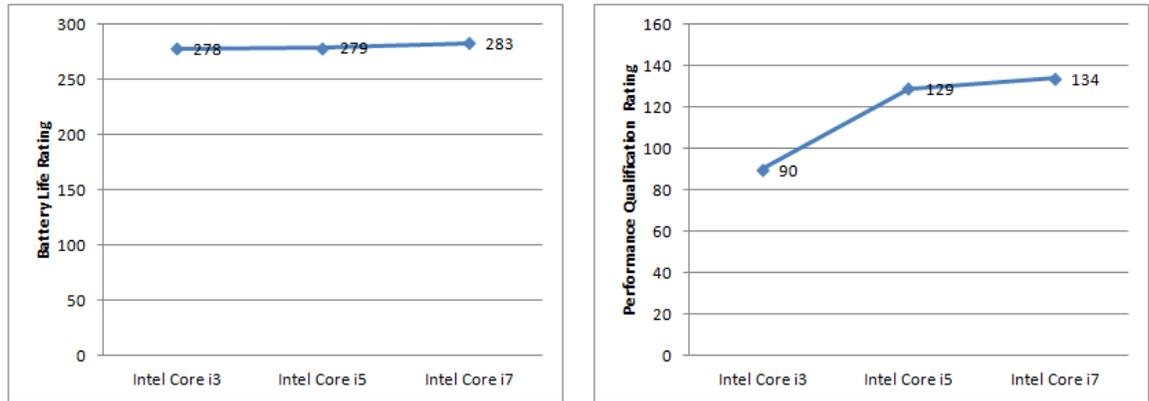


Figure 4: Sensitivity of Office Productivity scenario to different CPU configurations

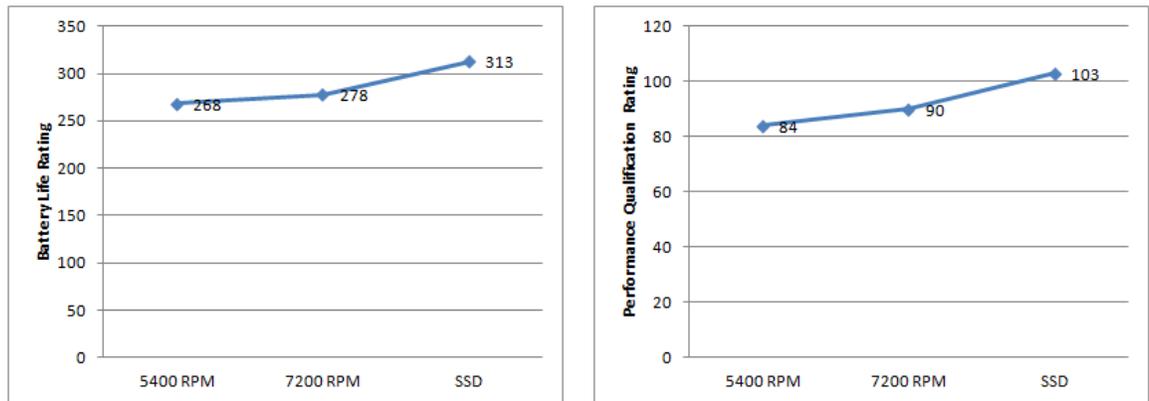


Figure 5: Sensitivity of Office Productivity scenario to different I/O configurations

3.3 Scenario Power Profiles

The following graphs plot the system power consumption of the MobileMark 2012 calibration system while running one iteration each of the Office Productivity and Media Creation & Consumption scenarios. Note that one iteration of the Media Creation & Consumption scenario runs considerably longer than one iteration of the Office Productivity scenario.

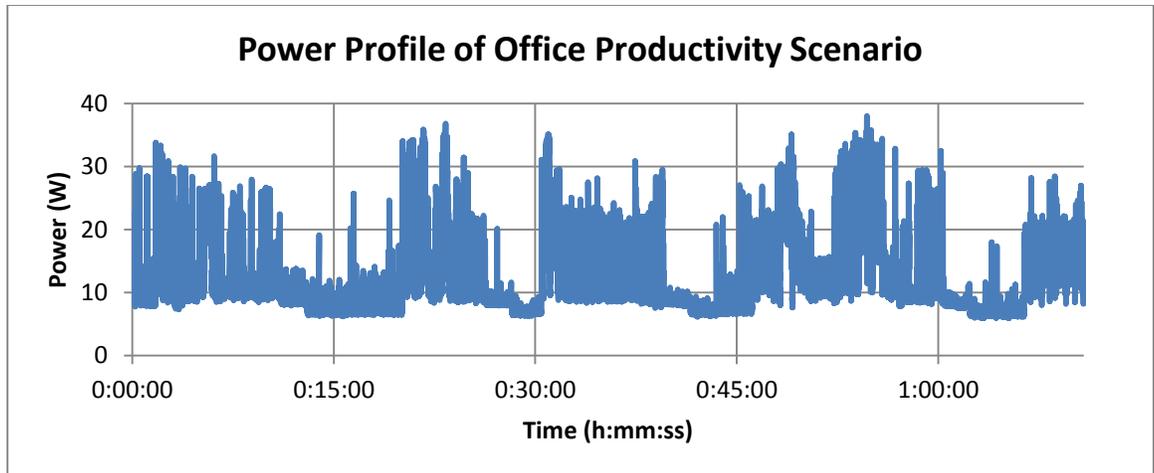


Figure 9: Power Profile of the Office Productivity Scenario on the MobileMark 2012 Calibration System (see section 2.7)

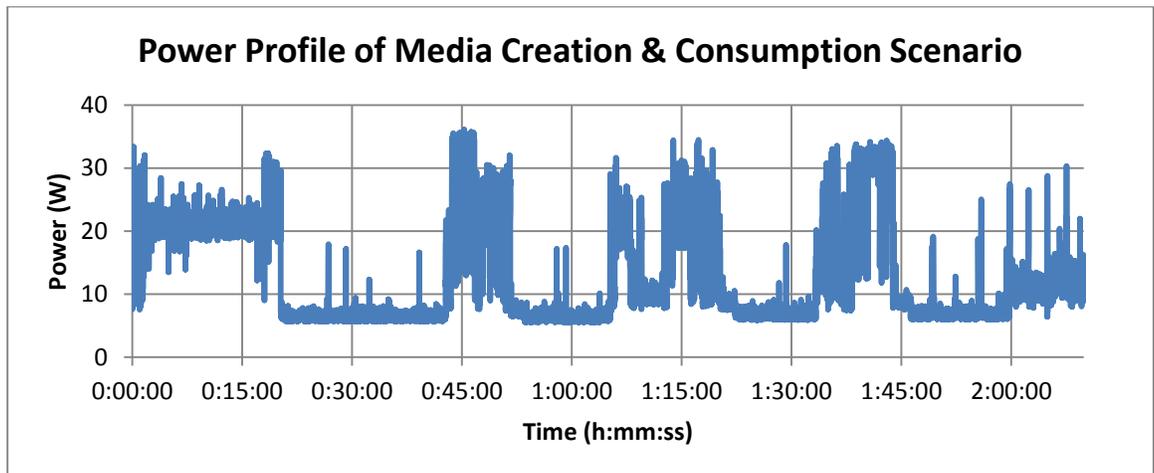


Figure 10: Power Profile of the Media Creation & Consumption Scenario on the MobileMark 2012 Calibration System (see section 2.7)

3.4 Scenario Battery Life Comparison

The following chart compares the battery life ratings obtained from running two MobileMark 2012 scenarios and the MobileMark 2007 Productivity scenario on the same MobileMark 2012 calibration system.

MobileMark 2012 battery life ratings will generally be considerably lower than MobileMark 2007 battery life ratings. This reflects the greater load placed upon the system by the higher display brightness, new workloads, increased workload intensity and updated applications of MobileMark 2012. The impact may vary from one system configuration to the next.

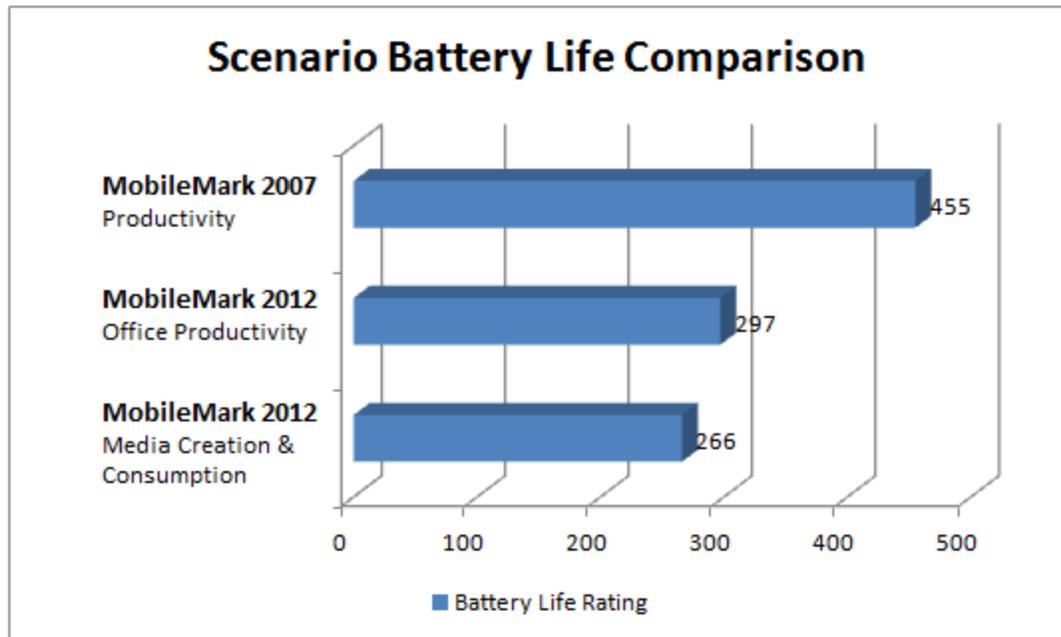


Figure 11: Comparison of Scenario Battery Life Ratings on the MobileMark 2012 Calibration System (see section 2.7)

APPENDIX A: Application Program Versions

The following applications are installed and used by MobileMark 2012:

- ABBYY® FineReader Pro 11
- Adobe® Acrobat® Pro X
- Adobe® Flash® Player 11
- Adobe® Photoshop® CS5 Extended 12.04
- Adobe® Photoshop® Elements 10
- Adobe® Premiere® Pro CS 5.5
- CyberLink PowerDVD Ultra 11
- Microsoft® Excel® 2010 SP1
- Microsoft® Internet Explorer® 9
 - Note: If Internet Explorer 9 or newer is already installed on the system, MobileMark 2012 uses the version already installed.
- Microsoft® Outlook® 2010 SP1
- Microsoft® PowerPoint® 2010 SP1
- Microsoft® Windows Media Player
 - Note: MobileMark 2012 uses the version of Windows Media Player already installed on the system.
- Microsoft® Word 2010 SP1
- Mozilla® Firefox® 10.0.2
 - Note: MobileMark 2012 v1.5 uses Mozilla® Firefox® 14.0.1
- WinZip® Pro 16

The following applications are installed and used by MobileMark 2012 Lite:

- ABBYY® FineReader Pro 11
- Adobe® Acrobat® Pro X
- Adobe® Flash® Player 11
- Adobe® Photoshop® CS5 32-bit
- Adobe® Photoshop® Elements 10
- Adobe® Premiere® Pro CS 4
- CyberLink PowerDVD Ultra 11
- Microsoft® Excel® 2010 SP1 32-bit
- Microsoft® Internet Explorer® 9
 - Note: If Internet Explorer 9 or newer is already installed on the system, MobileMark 2012 Lite uses the version already installed.
- Microsoft® Outlook® 2010 SP1 32-bit
- Microsoft® PowerPoint® 2010 SP1 32-bit
- Microsoft® Windows Media Player
 - Note: MobileMark 2012 Lite uses the version of Windows Media Player already installed on the system.
- Microsoft® Word 2010 SP1 32-bit
- Mozilla® Firefox® 14.0.1
- WinZip® Pro 16 32-bit

APPENDIX B: Minimum System Requirements

MobileMark 2012 system requirements:

- Windows 7 64-bit or Windows 8 64-bit
- 1.3 GHz dual core processor
- 3 GB system RAM
- DirectX 9-compatible graphics adapter
- At least 30 GB free space on the primary storage device
- 1024 x 768 display resolution (or higher)
- Blu-ray reader (required only for Blu-ray Playback scenario in MobileMark 2012)
- Wireless router (required only for Office Productivity and Media Creation & Consumption scenarios)

BAPCo has performed extensive testing of three wireless router models and recommends them for testing of the Office Productivity and Media Creation & Consumption scenarios:

- Linksys E3200 High-Performance Dual-Band N Router
- Netgear N900 Wireless Dual Band Gigabit Router (WNDR4500)
- Netgear ProSafe Wireless-N Access Point (WNAP320)

MobileMark 2012 Lite system requirements:

- Windows 7 (32-bit or 64-bit) or Windows 8 (32-bit or 64-bit)
- 1.3 GHz dual core processor
- 3 GB system RAM
- DirectX 9-compatible graphics adapter
- At least 30 GB free space on the primary storage device
- 1024 x 768 display resolution (or higher)
- Blu-ray reader (required only for Blu-ray Playback scenario in MobileMark 2012)
- Wireless router (required only for Office Productivity and Media Creation & Consumption scenarios)

BAPCo has performed extensive testing of three wireless router models and recommends them for testing of the Office Productivity and Media Creation & Consumption scenarios:

- Linksys E3200 High-Performance Dual-Band N Router
- Netgear N900 Wireless Dual Band Gigabit Router (WNDR4500)
- Netgear ProSafe Wireless-N Access Point (WNAP320)

Note: It may be possible to successfully run MobileMark 2012 or MobileMark 2012 Lite on systems that do not meet some of these requirements; however, BAPCo may not be able to provide support to users experiencing problems on such systems.

APPENDIX C: Screenshots

The screenshots below are included to illustrate the user interface and workloads included in MobileMark 2012. These screenshots may not accurately depict future releases of MobileMark 2012 or MobileMark 2012 Lite.



Figure 9: Test Setup

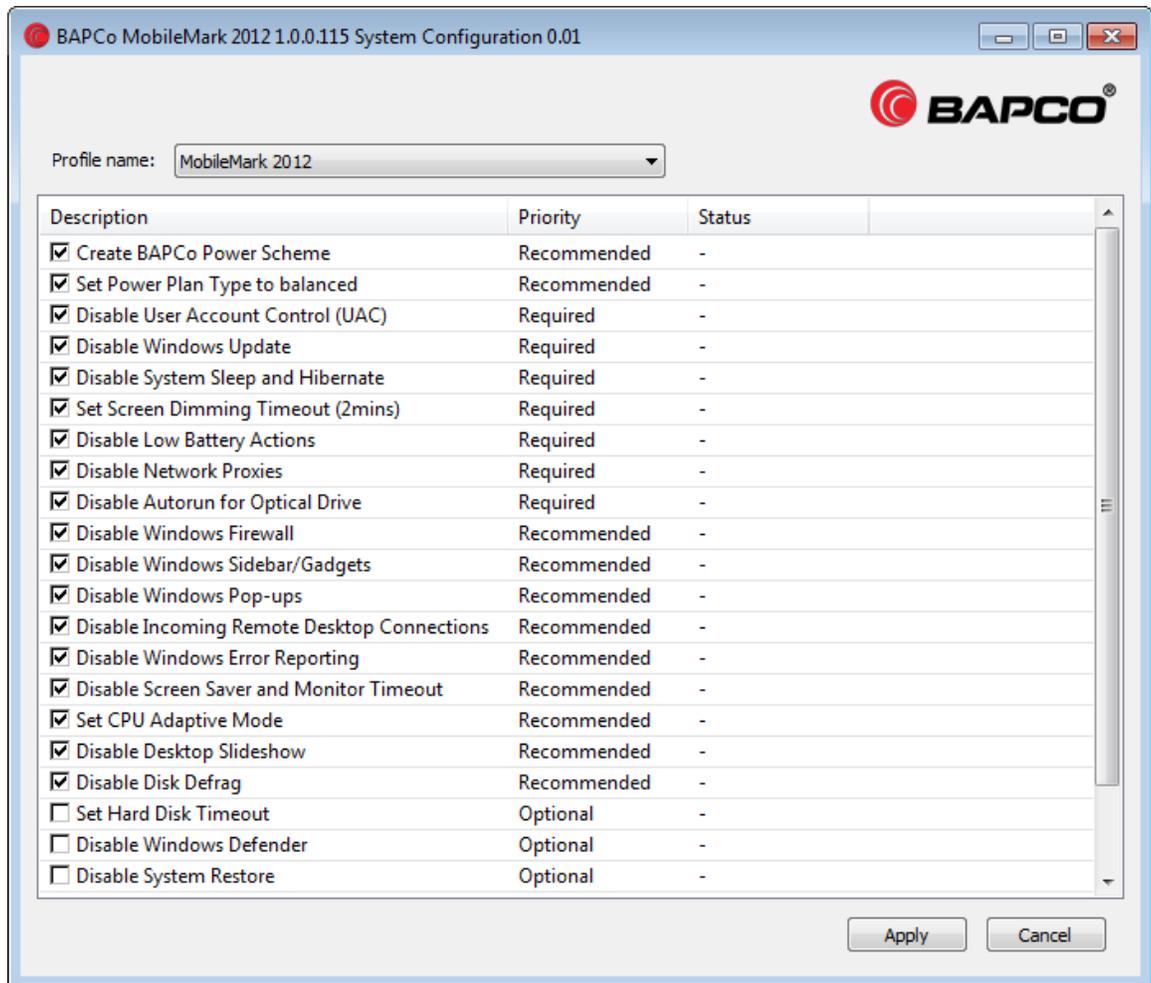


Figure 10: System Configuration
New built-in tool simplifies management of system configuration

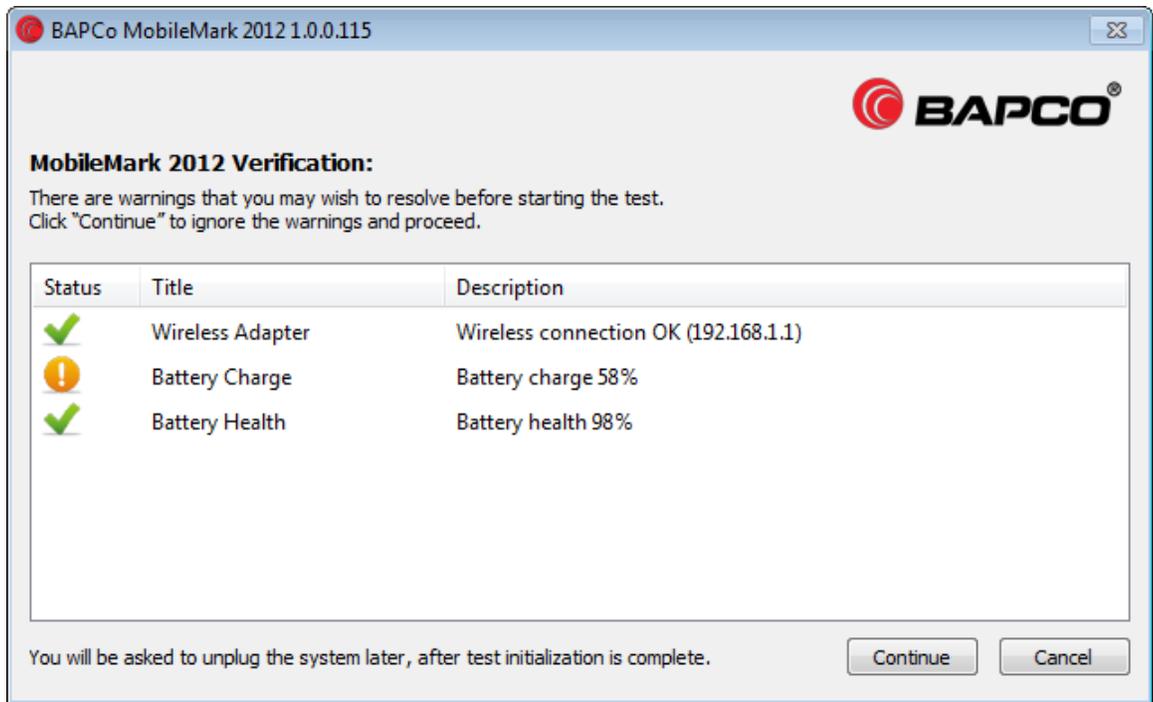


Figure 11: Pre-Test Verification Alerts you to potential problems before testing begins

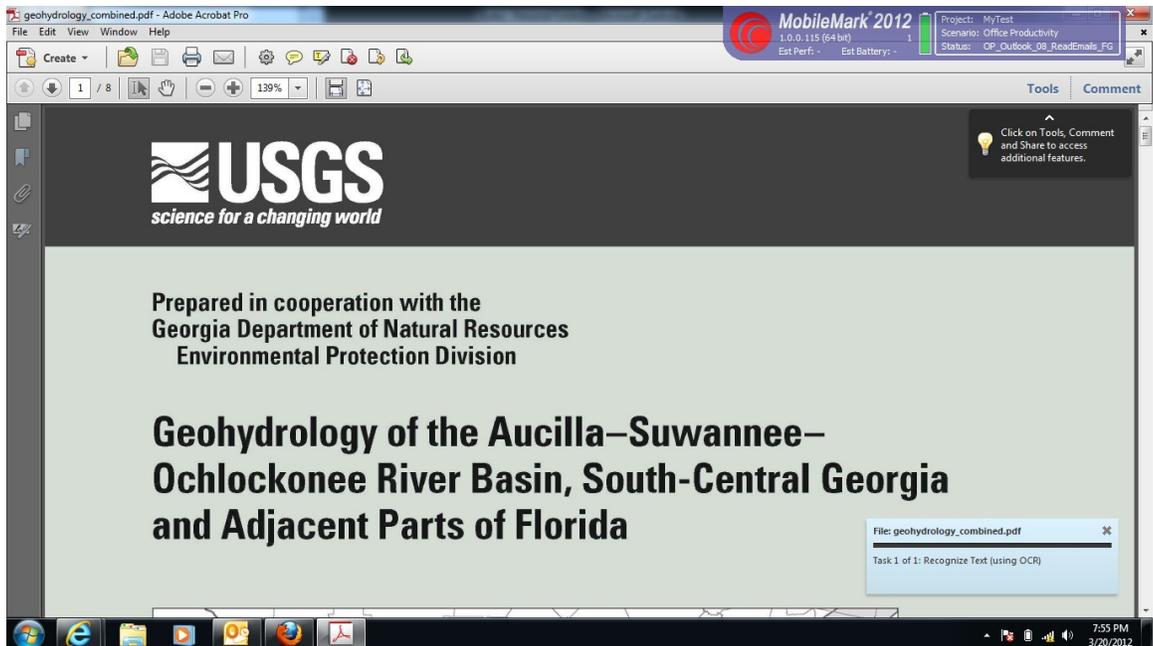


Figure 12: Office Productivity Scenario

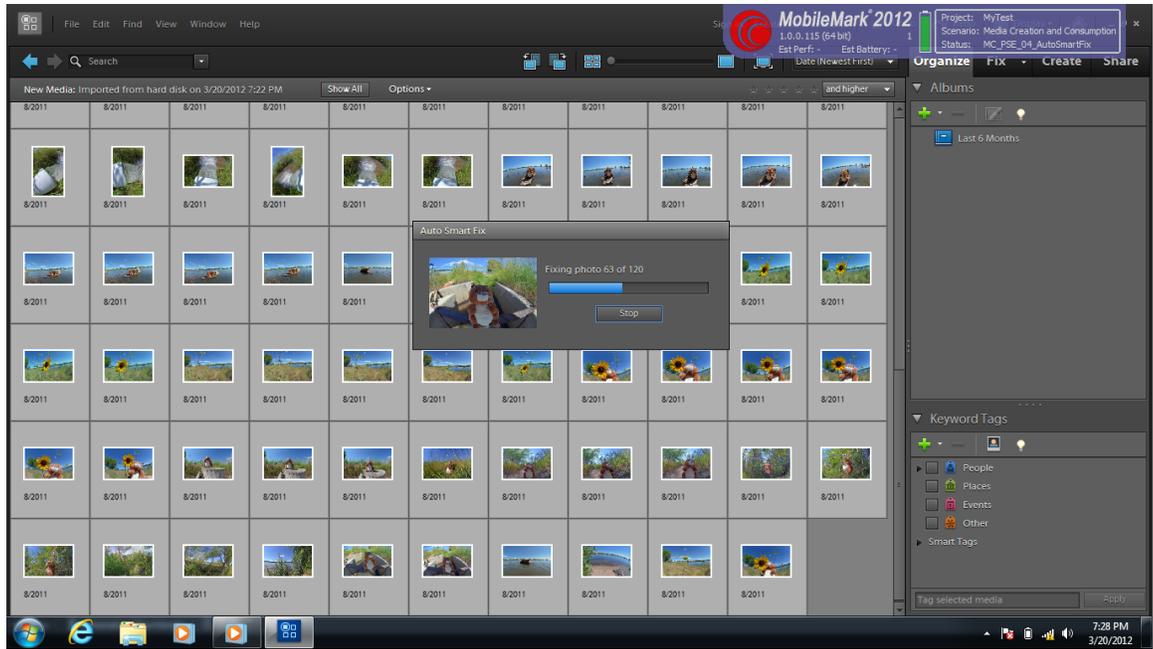
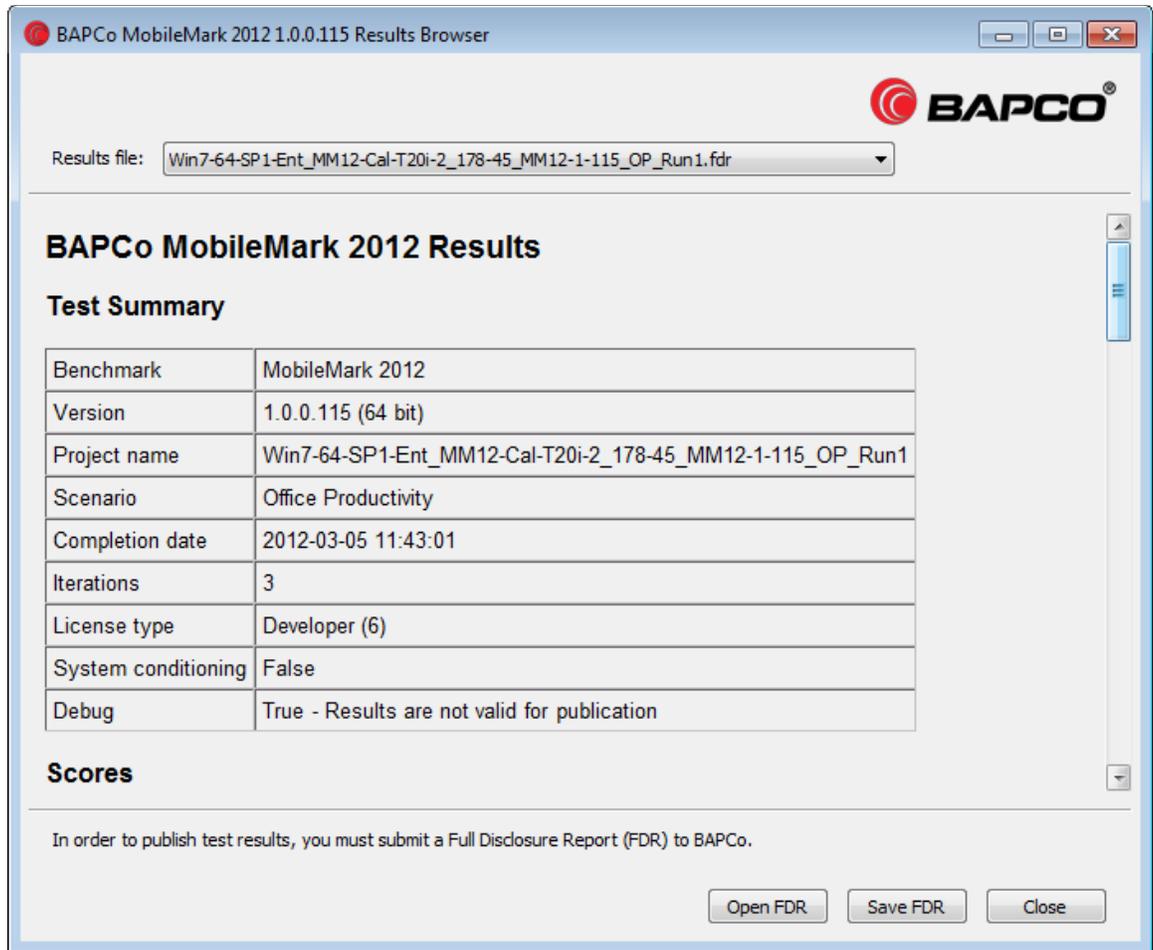


Figure 13: Media Creation & Consumption Scenario



The screenshot shows a window titled "BAPCo MobileMark 2012 1.0.0.115 Results Browser". At the top right is the BAPCo logo. Below it, a "Results file:" dropdown menu contains the text "Win7-64-SP1-Ent_MM12-Cal-T20i-2_178-45_MM12-1-115_OP_Run1.fdr".

BAPCo MobileMark 2012 Results

Test Summary

Benchmark	MobileMark 2012
Version	1.0.0.115 (64 bit)
Project name	Win7-64-SP1-Ent_MM12-Cal-T20i-2_178-45_MM12-1-115_OP_Run1
Scenario	Office Productivity
Completion date	2012-03-05 11:43:01
Iterations	3
License type	Developer (6)
System conditioning	False
Debug	True - Results are not valid for publication

Scores

In order to publish test results, you must submit a Full Disclosure Report (FDR) to BAPCo.

At the bottom right, there are three buttons: "Open FDR", "Save FDR", and "Close".

Figure 14: Results Browser Test Summary

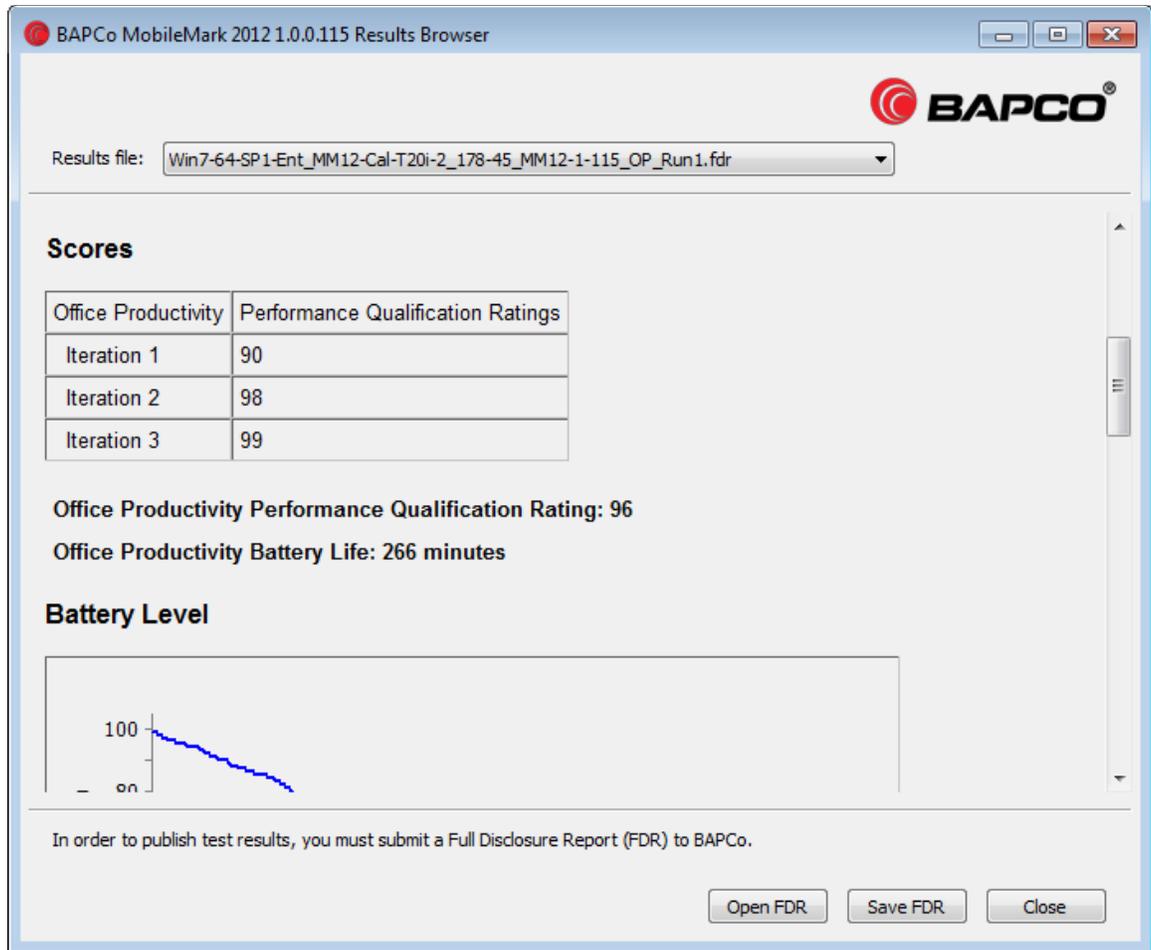


Figure 15: Results Browser Scores

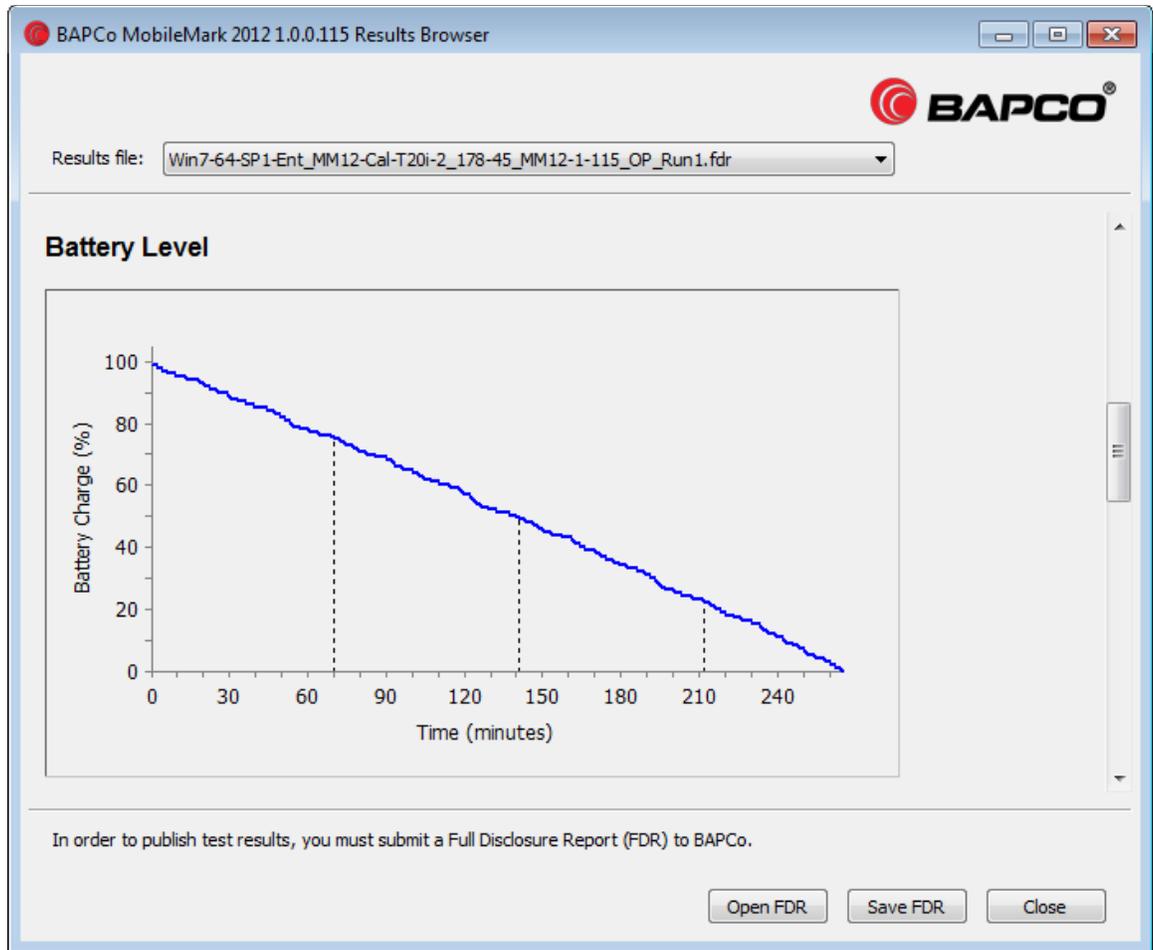


Figure 16: Results Browser Battery Level Plot

ADDENDUM I: MobileMark 2012 Sensitivity on Windows 8

Sensitivity Analysis on Windows 8

The following charts demonstrate the sensitivity of the MobileMark 2012 Office Productivity and Media Creation and Consumption scenarios to changes in individual hardware components.

These results were obtained using a system with the following base configuration:

- **Notebook model:** HP EliteBook 8570p
- **BIOS:** HP 68ICF version F.06 66.26, date 3 Aug 2012
- **CPU:** Intel Core i5-3320M Processor (2.60 GHz, 3MB L3)
- **Operating system:** Windows 8 Enterprise 64bit (retail copy OS installation with HP drivers installed)
- **Operating system language:** US English
- **Display type:** 15.6" (1600x900)
- **System graphics:** Radeon 7570m
- **System RAM:** 4 GB DDR3 1600 MHz (1 DIMM)
- **Keyboard:** US English
- **Hard drive:** Hitachi HTS727550A9E364 (500 GB Hard Disk Drive, 7200 RPM)
- **Optical device:** DVD RW
- **Battery:** 6 cell Li-Ion Battery –(62Wh)
- **Wireless LAN:** Intel 6502 a/g/n WLAN

For the charts below, the following components were substituted as noted:

- System RAM:
 - 2 GB DDR3 1600 MHz (1 DIMM)
 - 4 GB DDR3 1600 MHz (1 DIMM)
 - 8 GB DDR3 1600 MHz (1 DIMM)
- CPU:
 - Intel Celeron B810 (Dual Core 1.6 GHz, 2MB L3)
 - Intel Core i3-3110M Processor (Dual-Core, 2.4 GHz, 3 MB L3)
 - Intel Core i5-3320M Processor (Dual-Core, 2.6 GHz, 3 MB L3)
 - Intel Core i73520M Processor (Dual-Core, 2.9 GHz, 4 MB L3)
- Hard drive:
 - Hitachi HTS547564A9E384 (640 GB Hard Disk Drive, 5400 RPM)
 - Hitachi HTS727550A9E364 (500 GB Hard Disk Drive, 7200 RPM)
 - Intel 520 series - SSDSC2CW180A3 (180 GB Solid State Device)

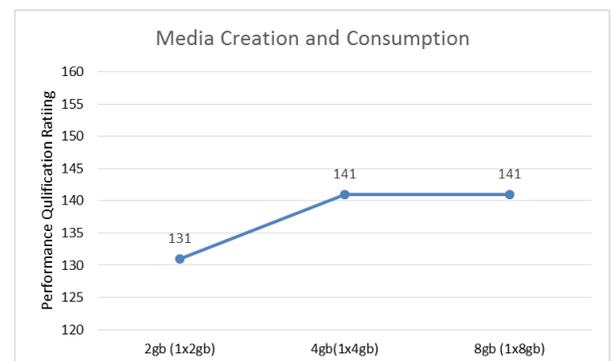
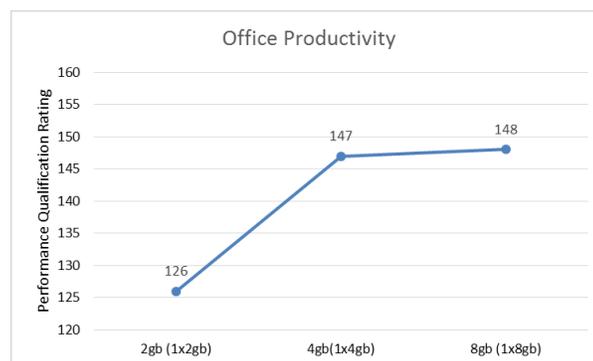


Figure 17: RAM sensitivity on Windows 8 x64

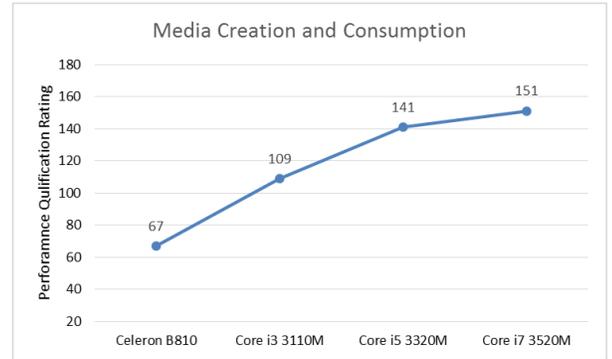
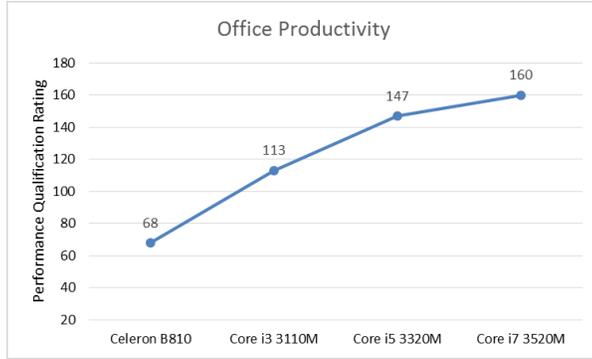


Figure 18: CPU sensitivity on Windows 8 x64

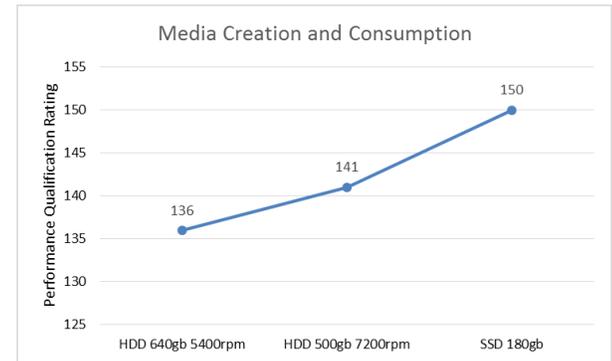
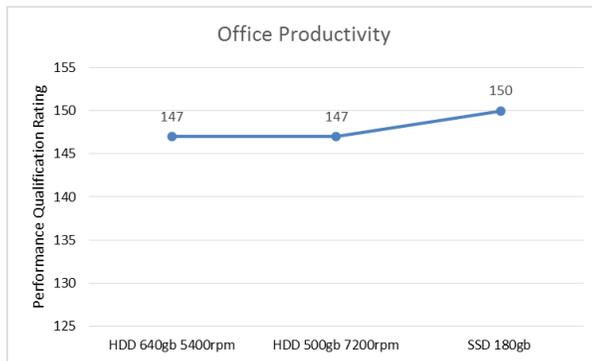


Figure 19: Disk drive sensitivity on Windows 8 x64

Battery life: Windows 7 vs Windows 8

The following chart shows compares battery life on Windows 7 (64bit) to Windows 8 (64bit), running MobileMark 2012 Office Productivity on the calibration system.

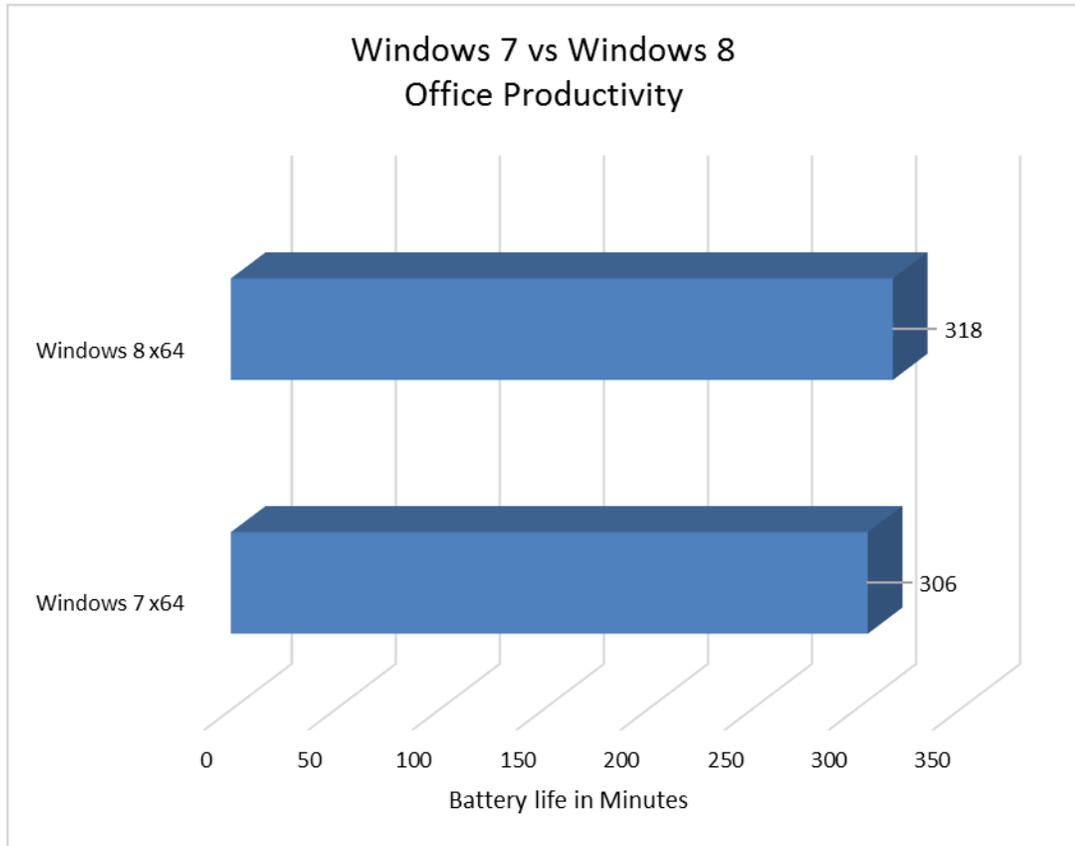


Figure 20: Windows 7 vs Windows 8 Office Productivity scenario battery life comparion

ADDENDUM II: MobileMark 2012 Lite Sensitivity Analysis

Component Sensitivity

The following charts demonstrate the sensitivity of MobileMark 2012 Lite Office Productivity and Media Creation and Consumption scenario to changes in individual hardware components.

These results were obtained using a system with the following base configuration:

- **Notebook model:** HP EliteBook 8570p
- **BIOS:** HP 68ICF version F.06 66.26, date 3 Aug 2012
- **CPU:** Intel Core i5-3320M Processor (2.60 GHz, 3MB L3)
- **Operating system:** Windows 8 Enterprise 32bit (retail copy OS installation with HP drivers installed)
- **Operating system language:** US English
- **Display type:** 15.6" (1600x900)
- **System graphics:** Radeon 7570m
- **System RAM:** 4 GB DDR3 1600 MHz (1 DIMM)
- **Keyboard:** US English
- **Hard drive:** Hitachi HTS727550A9E364 (500 GB Hard Disk Drive, 7200 RPM)
- **Optical device:** DVD RW
- **Battery:** 6 cell Li-Ion Battery –(62Wh)
- **Wireless LAN:** Intel 6502 a/g/n WLAN

For the charts below, the following components were substituted as noted:

- System RAM:
 - 2 GB DDR3 1600 MHz (1 DIMM)
 - 4 GB DDR3 1600 MHz (1 DIMM)
 - 8 GB DDR3 1600 MHz (1 DIMM)
- CPU:
 - Intel Celeron B810 (Dual Core 1.6 GHz, 2MB L3)
 - Intel Core i3-3110M Processor (Dual-Core, 2.4 GHz, 3 MB L3)
 - Intel Core i5-3320M Processor (Dual-Core, 2.6 GHz, 3 MB L3)
 - Intel Core i73520M Processor (Dual-Core, 2.9 GHz, 4 MB L3)
- Hard drive:
 - Seagate ST9160314AS (160 GB Hard Disk Drive, 5400 RPM)
 - Hitachi HTS727550A9E364 (500 GB Hard Disk Drive, 7200 RPM)
 - Intel 520 series - SSDSC2CW180A3 (180 GB Solid State Device)

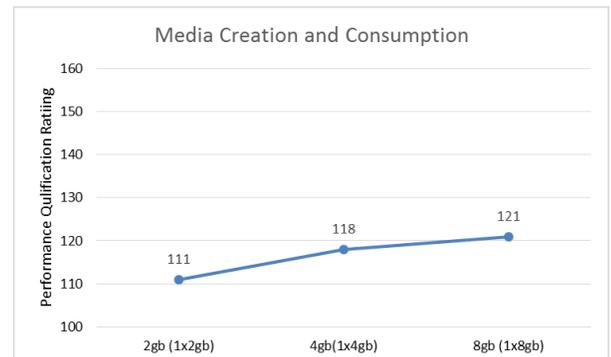
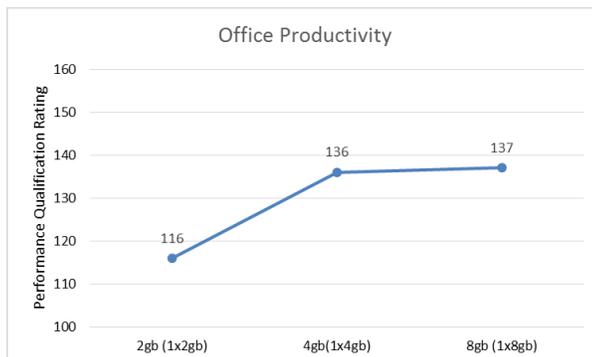


Figure 21: RAM sensitivity on Window 8 32-bit

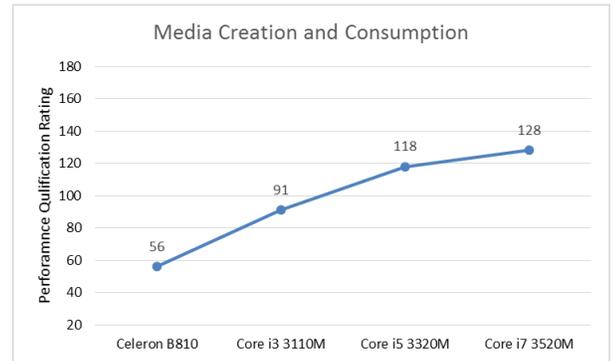
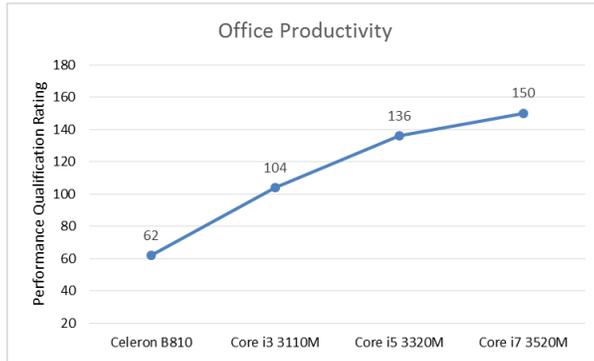


Figure 22: CPU sensitivity on Windows 8 32-bit

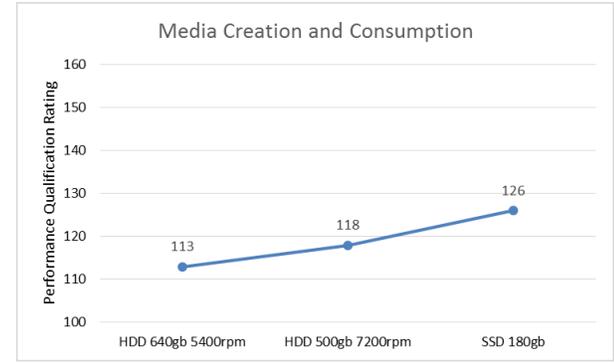
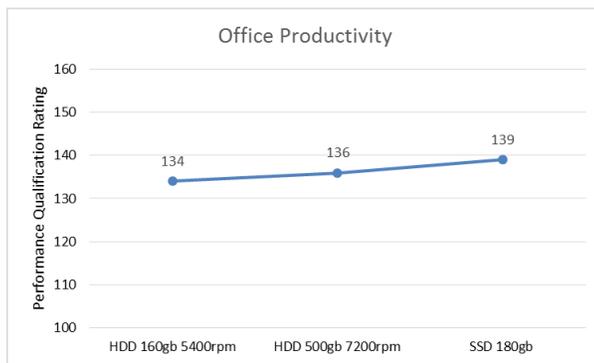


Figure 23: Disk drive sensitivity on Window 8 32bit

Battery life: Windows 7 vs Windows 8

The following chart shows compares battery life on Windows 7 (32-bit) to Windows 8 (32-bit), running MobileMark 2012 Office Productivity on the calibration system

