## Get a better experience
### WITH AN INTEL® CORE™ PROCESSOR-POWERED LENOVO® ULTRABOOK™*

| up to 104% better | up to 105% better | up to 104% better | save up to 6 minutes | up to 2 hours longer |
|---|---|---|---|---|
| Better high definition experience | Better overall system performance | Better graphics performance | Faster encoding | Longer battery life |
| HDXPRT 2012 | SYSmark® 2014 | 3DMark® Cloud Gate | Adobe® Premiere® Elements 13 | MobileMark® 2012 |

*versus the AMD processor-based notebooks we tested

Today's employees face many challenges, and today's technology helps them overcome these challenges. Your organization thrives on employees completing their tasks in a timely manner without sacrificing quality, from graphic intensive tasks such as media creation to compute intensive ones such as numeric calculations. How do you choose which laptop will help your employees get the job done?

In the Principled Technologies labs, we conducted hands-on testing to help with the buying decision. We compared an Intel Core i5 processor-powered Lenovo Ultrabook to a similarly priced AMD® A10 processor-based HP notebook, and an Intel Core i3 processor-powered Lenovo Ultrabook to a similarly priced AMD A6 processor-based HP notebook. We put the four systems through tests that included industry-standard benchmarks and timed tasks.

We found that both Intel processor-powered Lenovo Ultrabooks provided a better experience across the board than their respective competitive AMD processor-based HP notebooks: up to 105 percent better performance in industry-standard benchmarks, up to 6 minutes faster in timed tasks, and up to 2 hours longer battery life. With better performance, application responsiveness, and battery life, our hands-on testing shows that Intel processor-powered Lenovo Ultrabooks are the better choice for employee productivity during the workday.

NOVEMBER 2014

# A PRINCIPLED TECHNOLOGIES TEST REPORT
Commissioned by Intel Corp.

# WHICH NOTEBOOK OFFERS A BETTER EXPERIENCE?

Does it matter what processor you choose in a notebook? Does the processor matter when employees use common productivity applications such as Microsoft® Excel® and PowerPoint® or graphic-intensive applications such as Adobe Photoshop® Elements 13 and Premiere Elements 13? Does the processor matter for battery life and how often employees will need to recharge?

We put four systems through a series of tests to help answer those questions. We looked at the following comparisons:

- An Intel Core i5-4300U processor-powered Lenovo ThinkPad® T440s Ultrabook vs. an AMD A10 Pro-7350B processor-based HP EliteBook 745 G2 notebook
- An Intel Core i3-4030U processor-powered Lenovo ThinkPad T440 Ultrabook vs. an AMD A6 Pro-7050B processor-based HP EliteBook 725 G2 notebook

We configured the systems as similarly as possible; the systems shared the same amount of memory and storage. In addition, all four systems we tested were configured with 3-cell batteries. For detailed specifications of our test systems, see Appendix B.

We put the four systems through a series of tests that included industry-standard benchmarks to measure performance and battery life. We also timed tasks to measure application responsiveness. For more information on the benchmarks we used, see Appendix A. For detailed steps on how we conducted each test, see Appendix C.

# BENCHMARK PERFORMANCE
## HDXPRT 2012

In addition to graphics and video, other forms of digital media require significant compute power as well. The benchmark HDXPRT, the High Definition Experience & Performance Ratings Test, assesses capabilities of Microsoft Windows® 8.1-based systems for handling real-world media scenarios while using common consumer applications. We used HDXPRT to see how well the four systems performed tasks such as organizing and editing photos, videos, and music. Figure 1 shows the overall HDXPRT Create HD scores for the four systems. The Intel processor-powered Lenovo Ultrabooks scored up to 104.8 percent better than their AMD processor-based notebook counterparts, indicating they would be better suited to handle media creation and manipulation demands.

**Figure 1: HDXPRT 2012 scores for the four test systems. Higher scores are better.**
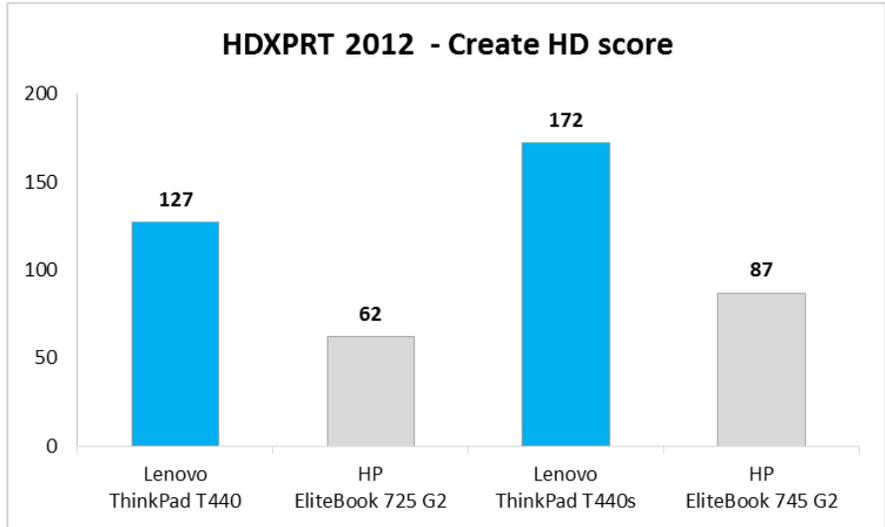
## BAPCo SYSmark 2014

Users often employ a number of different applications to complete work-related tasks. BAPCo® SYSmark 2014 is an industry-standard benchmark that measures performance in areas such as productivity, media creation, and financial analysis. As Figure 2 shows, the Intel processor-powered Lenovo Ultrabooks outperformed their AMD processor-based notebook counterparts by up to 105.2 percent.



**Figure 2: SYSmark 2014 scores for the four test systems. Higher scores are better.**
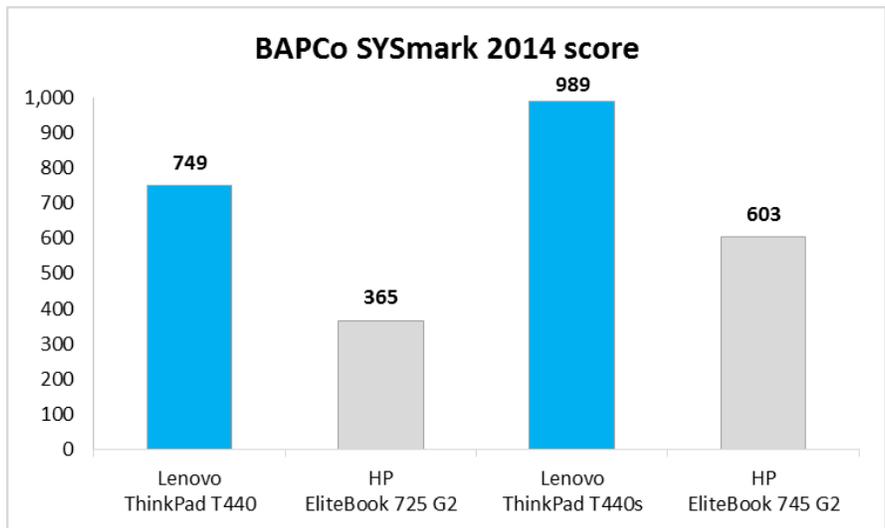
## Futuremark 3DMark

Those who work with graphics-intensive applications absolutely need strong performance in this area. Graphics performance can also affect general responsiveness for users who do not use such applications. We used Futuremark® 3DMark® v1.4.778 Cloud Gate to measure the graphics performance of the four test systems. Designed for Windows notebooks and home PCs, Cloud Gate includes graphics and physics tests. As

Figure 3 shows, we found that the Intel processor-powered Lenovo Ultrabooks outperformed their AMD processor-based notebook counterparts in median score, graphics score, and physics score, including up to 104.8 percent higher for the median score.

**Figure 3: 3DMark Cloud Gate median, graphics, and physics scores for the four test systems. Higher numbers are better.**
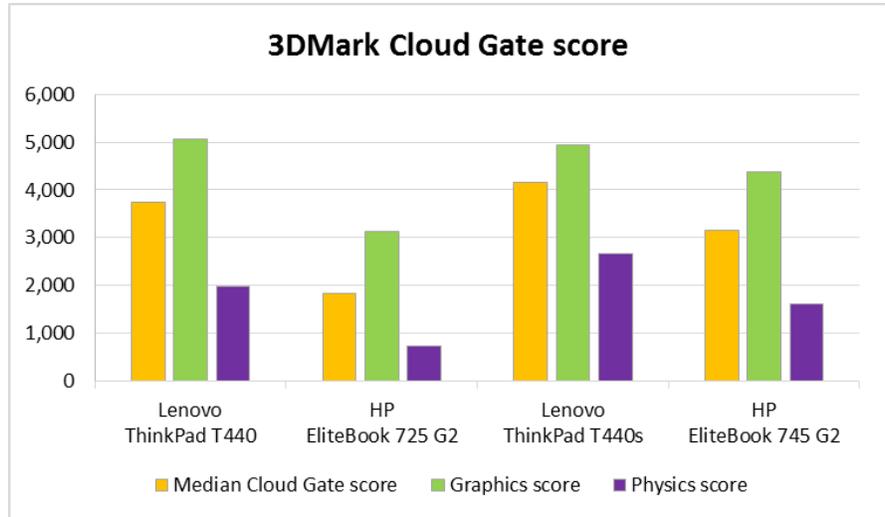


## WebXPRT 2013

WebXPRT 2013 measures Web-browsing performance of any Web-enabled device by simulating everyday usage scenarios. The benchmark calculates an overall score from the times the test system took to complete tasks from four workloads. As Figure 4 shows, the Intel processor-powered Lenovo Ultrabooks scored up to 29.4 percent higher than their AMD processor-based notebook counterparts did.

**Figure 4: WebXPRT 2013 scores for the four test systems. Higher scores are better.**
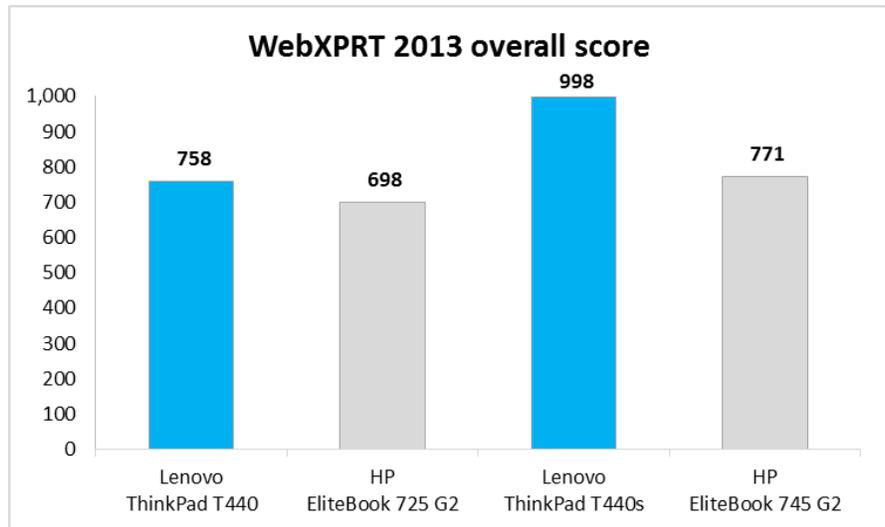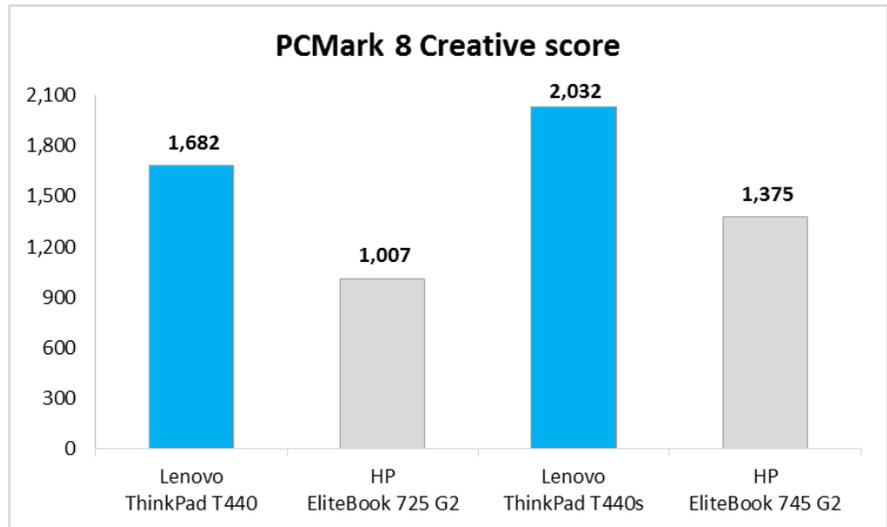


## Futuremark PCMark 8

The latest version of this benchmark, Futuremark® PCMark® 8 v2.2.282 measures various aspects of performance for a range of Windows-based devices. For

our testing, we chose Home, Creative, Work, and Storage scenarios. Figure 5 shows the results from the Creative scenario and Figure 6 shows the scores for each scenario for the four test systems. The Intel Core i3 processor-powered Lenovo T440 Ultrabook scored up to 67.0 percent higher than the AMD A6 processor-based HP EliteBook 725 G2, and the Intel Core i5 processor-powered Lenovo T440s Ultrabook scored up to 47.8 percent better than the AMD A10 processor-based HP EliteBook 745 G2.

**Figure 5: PCMark 8 Creative scenario scores for the four test systems. Higher scores are better.**

**PCMark 8 Creative score**

| System | Score |
|--------|-------|
| Lenovo ThinkPad T440 | 1,682 |
| HP EliteBook 725 G2 | 1,007 |
| Lenovo ThinkPad T440s | 2,032 |
| HP EliteBook 745 G2 | 1,375 |

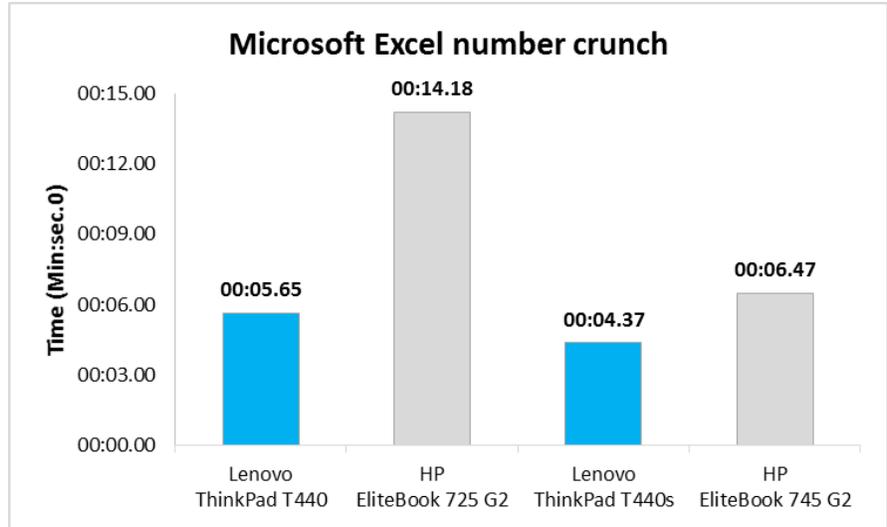|  | Lenovo ThinkPad T440 | HP EliteBook 725 G2 | Percent win for Lenovo Ultrabook | Lenovo ThinkPad T440s | HP EliteBook 745 G2 | Percent win for Lenovo Ultrabook |
|---|---|---|---|---|---|---|
| Home score | 2,029 | 1,437 | 41.2% | 2,397 | 1,870 | 28.2% |
| Creative score | 1,682 | 1,007 | 67.0% | 2,032 | 1,375 | 47.8% |
| Work score | 2,409 | 1,865 | 29.2% | 3,079 | 2,207 | 39.5% |
| Storage score | 2,383 | 2,232 | 6.8% | 2,686 | 2,224 | 20.8% |

**Figure 6: Results and analysis for PCMark 8 scenario tests. Higher numbers are better.**

# APPLICATION RESPONSIVENESS

## Crunching numbers in Microsoft Excel

Tabulating numbers in a spreadsheet is a relatively common task for many users. However, computing large quantities of numbers can stress processors and slow down performance. To see how the four systems would handle this type of work, we ran a command that performed calculations in a Microsoft Excel spreadsheet full of numeric data. We found that the Intel processor-powered Lenovo Ultrabooks completed the workload in up to 60.2 percent less time than their AMD processor-based HP EliteBook counterparts did. Figure 7 shows how long each system took to crunch numbers in Excel.

**Figure 7: The times for each system to crunch numbers in Excel. Lower numbers are better.**

## Launching Microsoft PowerPoint

Launching productivity applications, such as PowerPoint, can provide insight into a system's responsiveness when a user would be getting work done on the notebook. We found that both Intel processor-powered Lenovo Ultrabooks launched PowerPoint in less time than did the AMD processor-based notebooks. Figure 8 shows the times for the four notebooks to launch PowerPoint and the percentage wins for the Intel processor-powered Lenovo Ultrabooks.

| | Lenovo ThinkPad T440 | HP EliteBook 725 G2 | Percent win for Lenovo Ultrabook | Lenovo ThinkPad T440s | HP EliteBook 745 G2 | Percent win for Lenovo Ultrabook |
|---|---|---|---|---|---|---|
| Time to launch PowerPoint (mm:ss.00) | 00:01.94 | 00:02.07 | 6.3% | 00:01.48 | 00:02.02 | 26.7% |

**Figure 8: Results and analysis for this responsiveness task. Lower numbers are better for times and higher numbers are better for percentages.**

## Adobe Photoshop Elements 13 – Opening a project & converting to JPEG

Adobe Photoshop Elements is a picture editor that can open and convert projects from one format to another. Due to file sizes and the nature of the application, these tasks can take longer than other productivity applications. As Figure 9 shows, we found that the two Intel processor-powered Lenovo Ultrabooks took less time to perform both of these tasks than did the AMD processor-based notebooks.

**Figure 9: Time the four test systems needed to launch an Adobe Photoshop Elements 13 project and convert it to JPEG. Lower times are better.**
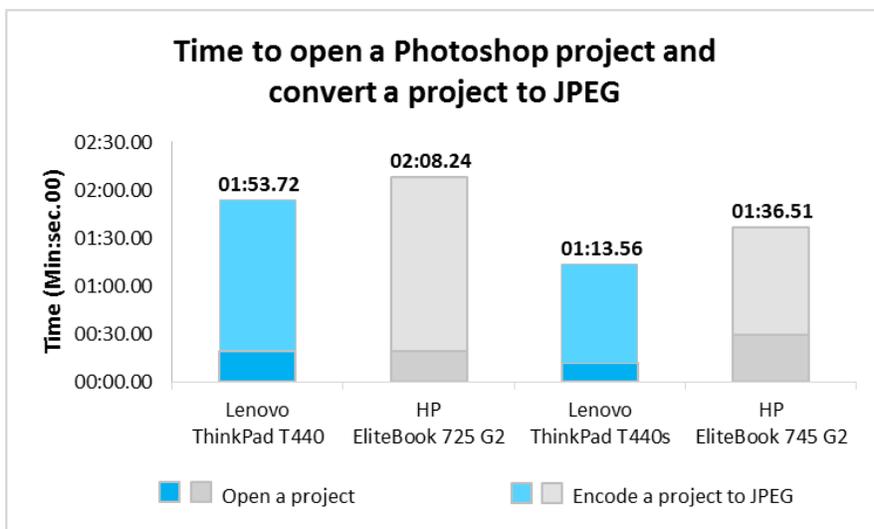
Figure 10 shows the times for the four notebooks to complete both tasks and the percentage wins for the Intel processor-powered Lenovo Ultrabooks vs. the AMD processor-based HP notebooks. An employee using Adobe Photoshop Elements 13 would save valuable time with an Intel processor-powered Lenovo Ultrabook.

|  | Lenovo ThinkPad T440 | HP EliteBook 725 G2 | Percent win for Lenovo Ultrabook | Lenovo ThinkPad T440s | HP EliteBook 745 G2 | Percent win for Lenovo Ultrabook |
|---|---|---|---|---|---|---|
| Time to open a project (mm:ss.00) | 00:19.41 | 00:19.46 | 0.3% | 00:11.85 | 00:29.61 | 60.0% |
| Time to convert a project to JPEG (mm:ss.00) | 01:34.31 | 01:48.78 | 13.3% | 01:01.71 | 01:06.90 | 7.8% |

**Figure 10: Results and analysis for these responsiveness tasks. Lower numbers are better for times and higher numbers are better for percentages.**

## Adobe Premiere Elements 13 – Opening a project & converting to MPEG

Like Photoshop Elements 13, Adobe Premiere Elements 13 can take a while to open a project or convert projects from one format to another. Performing these actions many times in a day on a slower system can cut into productivity. As Figure 11 shows, we found that the two Intel processor-powered Lenovo Ultrabooks took less time to open a project and encode a project to MPEG than did the AMD processor-based notebooks. The biggest wins were in converting a project to MPEG—the Intel Core i3 processor-powered Lenovo T440 Ultrabook completed the task over six minutes faster than did its AMD processor-based counterpart. The Intel Core i5 processor-powered Lenovo T440s Ultrabook was almost two minutes faster than its AMD processor-based counterpart.
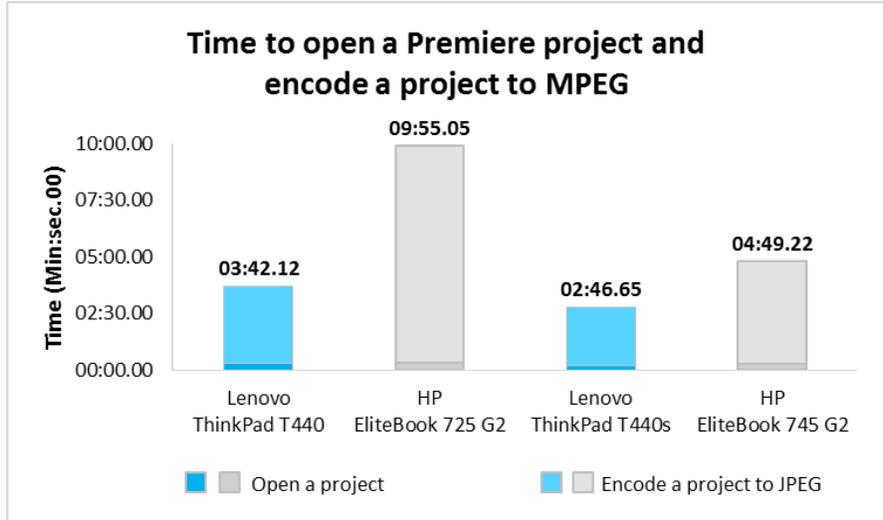
Figure 12 shows the times for the four notebooks to complete both tasks and the percentage wins for the Intel processor-powered Lenovo Ultrabooks. An employee using an Intel processor-powered Lenovo Ultrabook would save up to 6 minutes when converting a project in Adobe Premiere Elements 13.

| | Lenovo ThinkPad T440 | HP EliteBook 725 G2 | Percent win for Lenovo Ultrabook | Lenovo ThinkPad T440s | HP EliteBook 745 G2 | Percent win for Lenovo Ultrabook |
|---|---|---|---|---|---|---|
| Time to open a project (mm:ss.00) | 00:18.65 | 00:19.62 | 4.9% | 00:10.52 | 00:16.09 | 34.6% |
| Time to convert a project to MPEG (mm:ss.00) | 03:23.47 | 09:35.43 | 64.6% | 02:36.13 | 04:33.13 | 42.8% |

**Figure 12: Results and analysis for these responsiveness tasks. Lower numbers are better for times and higher numbers are better for percentages.**

# BATTERY LIFE PERFORMANCE

## BAPCo MobileMark 2012

Battery life depends on the performance of the processor as it runs applications in addition to battery capacity. The MobileMark benchmark creates a score for battery life from its tested applications. As Figure 13 shows, we found that the Intel Core i3 processor-powered Lenovo T440 Ultrabook lasted over two hours longer on a single charge than did the AMD A6 processor-based HP EliteBook 725 G2. We also found that the Intel Core i5 processor-powered Lenovo T440s Ultrabook lasted one and a half hours longer than did the AMD A10 processor-based HP EliteBook 745 G2. This means that the Intel processor-powered Lenovo Ultrabooks would be more convenient for employees that are often on the go.

**Figure 13: MobileMark 2012 Battery Life scores for the four test notebooks. Higher scores are better.**
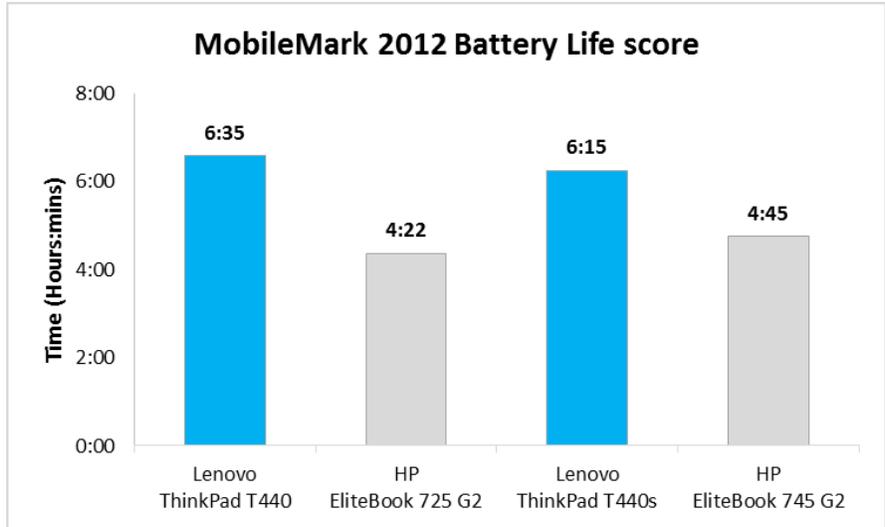
# CONCLUSION

Workers have a range of tasks to complete and use a number of different applications. Laptops for these users, while providing advantages in mobility, are not always equal in terms of performance, experience, or battery life. We found that Intel Core i5 and Core i3 processor-powered Lenovo Ultrabooks provided a number of advantages in performance and application responsiveness over comparable AMD processor-based notebooks, while also delivering better battery life. When your organization needs notebooks for a broad range of users performing different yet vital tasks, our testing shows that an Intel processor-powered Lenovo Ultrabook could offer a better experience than AMD processor-based HP EliteBook notebooks.

# APPENDIX A – ABOUT THE BENCHMARKS

## About HDXPRT 2012

The High Definition Experience & Performance Ratings Test (HDXPRT) 2012 is a benchmark that evaluates the capabilities of PCs in consumer digital media uses, including

- Media Organizer
- Media Creator
- Photo Blogger
- Video Producer
- Music Maker

For more information on HDXPRT 2012, see www.hdxprt.com.

## About BAPCo SYSmark 2014

According to BAPCo, "SYSmark 2014 is an application-based benchmark that reflects usage patterns of business users in the areas of office productivity, media creation, and data/financial analysis." The benchmark features notable applications from these fields. SYSmark 2014 generates a score from the times the tested system takes to complete each individual operation in each scenario. For more information on this benchmark, see bapco.com/products/sysmark-2014.

## About Futuremark 3DMark (2013) v1.4.778

Futuremark 3DMark v1.4.778 is a collection of benchmarks designed to rate the graphics performance of smartphones, tablets, notebooks, laptops, desktops, or high-performance gaming PCs. 3DMark includes benchmarks designed for Windows, Apple®, and Android™ devices.

Cloud Gate is for Windows notebooks and home PCs. This new test includes two graphics tests and a physics test and uses a DirectX® 11 engine limited to Direct3D® feature level 10, which makes it suitable for testing DirectX 10 compatible hardware. Cloud Gate is only available in the Windows editions of 3DMark at this time.

For more information on 3DMark, see www.futuremark.com/benchmarks/3dmark.

## About WebXPRT 2013

WebXPRT 2013 uses scenarios created to mirror the tasks you do every day to compare the performance of almost any Web-enabled device. It contains four HTML5- and JavaScript-based workloads: Photo Effects, Face Detect, Stocks Dashboard, and Offline Notes. From these workloads, the benchmark calculates a composite Overall Score for easy comparison. For more information about WebXPRT, visit www.webxprt.com.

## About Futuremark PCMark 8 v2.2.282

According to Futuremark, "PCMark 8 is the latest version in our series of industry standard PC-benchmarking tools." PCMark 8 evaluates the performance of PCs from tablets to desktops by using real-world tasks and applications. Applications are divided into scenarios that reflect common usage in different capacities. For our testing, we used the following four parts of the benchmark:

- **Home** – workloads reflecting common tasks for a typical home user and that have low computational requirements, including workloads for Web-browsing, writing, gaming, photo editing, and video chat
- **Creative** – workloads typical of enthusiasts and professionals who work with media and entertainment content and that have more demanding requirements than the Home benchmark, including workloads for Web-browsing, photo editing, video editing, group video chat, media transcoding, and gaming

- **Work** – workloads that test a system's ability to perform basic office work tasks, such as writing documents, browsing Web sites, creating spreadsheets, and using video chat
- **Storage** – workloads that test the performance of SSDs, HDDs, and hybrid drives with traces recorded from Adobe Creative Suite®, Microsoft Office, and a selection of popular games

For more information on this benchmark, see www.futuremark.com/benchmarks/pcmark8.

## About BAPCo MobileMark 2012

MobileMark 2012 is an industry-standard benchmark that provides a battery life rating and a performance rating based on common office scenarios. These include office activities like file and document management, data processing, and rich content creation. This module provides a score for battery life of the tested applications. In our tests, we focus solely on the battery life rating provided by MobileMark 2012.

MobileMark 2012 includes the following applications with their corresponding tasks:

- 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
- Microsoft Outlook® 2010 SP1
- Microsoft PowerPoint 2010 SP1
- Microsoft Windows Media® Player
- Microsoft Word 2010 SP1
- Mozilla® Firefox® 10.0.2
- WinZip® Pro 16

MobileMark 2012 measures system battery life in minutes. It records system battery life at the start of the benchmark and repeats the workload until the system battery life is depleted, or until the system powers down due to low battery life.

MobileMark 2012 records a timestamp once per minute. At the end of the benchmark, it compares the beginning timestamp to the final (last recorded) timestamp. MobileMark 2012 derives its system battery life rating as the number of minutes between the start and end timestamps.

For more information on this benchmark, see www.bapco.com/products/mobilemark2012/index.php.

# APPENDIX B – SYSTEM CONFIGURATION INFORMATION

Figure 14 provides detailed configuration information for the two Intel processor-powered Lenovo Ultrabooks.

| System | Lenovo ThinkPad T440 Ultrabook | Lenovo ThinkPad T440s Ultrabook |
|---|---|---|
| **General** | | |
| Number of processor packages | 1 | 1 |
| Number of cores per processor | 2 | 2 |
| Number of hardware threads per core | 2 | 2 |
| Total number of processor threads in system | 4 | 4 |
| System power management policy | Energy Saver | Energy Saver |
| Processor power-saving option | Enhanced Intel SpeedStep® Technology | Enhanced Intel SpeedStep Technology |
| System dimensions (length × width × height) | 13.34" × 0.82" × 9.15" | 13.03" × 8.89" × 0.80" |
| System weight | 3.76 lbs. | 3.48 lbs. |
| **CPU** | | |
| Vendor | Intel | Intel |
| Name | Core i3 | Core i5 |
| Model number | 4030U | 4300U |
| Stepping | C0 | C0 |
| Socket type and number of pins | Socket 1168 BGA | Socket 1168 BGA |
| Core frequency (GHz) | 1.9 | 1.9 / 2.9 Turbo |
| L1 cache | 2 × 32 KB + 2 × 32 KB | 2 × 32 KB + 2 × 32 KB |
| L2 cache | 2 × 256 KB | 2 × 256 KB |
| L3 cache | 3 MB | 3 MB |
| **Platform** | | |
| Vendor | Lenovo | Lenovo |
| Motherboard model number | 20B6009TUS | 20AQ005QUS |
| Motherboard chipset | Intel Haswell-ULT | Intel Haswell-ULT |
| BIOS name and version | Lenovo GJET78WW 2.28 (07/29/2014) | Lenovo GJET77WW 2.27 (05/20/2014) |
| **Memory module(s)** | | |
| Vendor and model number | Hyundai HMT351S6EFR8A-PB | Hyundai HMT351S6EFR8A-PB |
| Type | PC3-12800 | PC3-12800 |
| Speed (MHz) | 1,600 | 1,600 |
| Speed running in the system (MHz) | 1,600 | 1,600 |
| Timing/Latency (tCL-tRCD-tRP-tRASmin) | 11-11-11-28 | 11-11-11-28 |
| Size (MB) | 4,096 | 4,096 |
| Number of memory module(s) | 1 | 1 |
| Total amount of system RAM (GB) | 4 | 4 |
| Channel (single/dual) | Single | Single |

| System | Lenovo ThinkPad T440 Ultrabook | Lenovo ThinkPad T440s Ultrabook |
|---|---|---|
| **Hard disk** | | |
| Vendor and model number | HGST HTS725050A7E6300 | HGST HTS725050A7E6300 |
| Number of disks in system | 1 | 1 |
| Size (GB) | 500 | 500 |
| Buffer size (MB) | 32 | 32 |
| RPM | 7,200 | 7,200 |
| Type | SATA 6.0 Gb/s | SATA 6.0 Gb/s |
| Controller | Intel 8 Series Chipset Family SATA AHCI Controller | Intel 8 Series Chipset Family SATA AHCI Controller |
| Driver | Intel 12.8.10.1005 (11/15/2013) | Intel 12.8.10.1005 (11/15/2013) |
| **Operating system** | | |
| Name | Microsoft Windows 7 Professional x64 | Microsoft Windows 7 Professional x64 |
| Build number | 7601 | 7601 |
| Service Pack | 1 | 1 |
| File system | NTFS | NTFS |
| Kernel | ACPI x64-based PC | ACPI x64-based PC |
| Language | English | English |
| Microsoft DirectX version | DirectX 11 | DirectX 11 |
| **Graphics** | | |
| Vendor and model number | Intel HD Graphics 4400 | Intel HD Graphics 4400 |
| Type | Integrated | Integrated |
| Chipset | Intel HD Graphics Family | Intel HD Graphics Family |
| BIOS version | 2175.0 | 2175.0 |
| Total available graphics memory (MB) | 1,696 | 1,696 |
| Dedicated video memory (MB) | 64 | 64 |
| System video memory (MB) | 0 | 0 |
| Shared system memory (MB) | 1,632 | 1,632 |
| Resolution | 1,366 × 768 | 1,366 × 768 |
| Driver | Intel 10.18.10.3412 (01/29/2014) | Intel 10.18.10.3412 (01/29/2014) |
| **Sound card/subsystem** | | |
| Vendor and model number | Realtek® High Definition Audio | Realtek High Definition Audio |
| Driver | Realtek 6.0.1.7188 (03/04/2014) | Realtek 6.0.1.7127 (12/30/2013) |
| **Ethernet** | | |
| Vendor and model number | Intel Ethernet I218-V | Intel Ethernet I218-LM |
| Driver | Intel 12.11.77.1 (03/13/2014) | Intel 12.8.33.9427 (07/12/2013) |
| **Wireless** | | |
| Vendor and model number | Intel Dual Band Wireless-N 7260 | Intel Dual Band Wireless-AC 7260 |
| Driver | Intel 17.0.5.8 (06/18/2014) | Intel 16.8.0.6 (12/5/2013) |
| **USB ports** | | |
| Number | 2 | 3 |
| Type | USB 3.0 | USB 3.0 |

| System | Lenovo ThinkPad T440 Ultrabook | Lenovo ThinkPad T440s Ultrabook |
|---|---|---|
| Other | Media card reader, Display port | Media card reader, Display port |
| **Monitor** | | |
| LCD type | HD LED | HD LED |
| Screen size | 14" | 14" |
| Refresh rate | 60 Hz | 60 Hz |
| **Battery** | | |
| Type | Integrated 3-cell Li-Polymer<br>Rear: 3-cell Li-Polymer | Integrated 3-cell Li-Polymer<br>Rear: 3-cell Li-Polymer |
| Size (length × width × height) | Rear: 8.14" × 2.49" × 0.38" | Rear: 8.14" × 2.49" × 0.38" |
| Rated capacity | Integrated (23.5 Whr)<br>Rear: (23.2 Whr) | Integrated (23.5 Whr)<br>Rear: (23.2 Whr) |
| Weight | 0.33 lb. | 0.33 lb. |

**Figure 14: Detailed information for the tested Intel processor-powered Lenovo Ultrabooks.**

Figure 15 provides detailed configuration information for the AMD processor-based HP EliteBook notebooks.

| System | HP EliteBook 725 G2 | HP EliteBook 745 G2 |
|---|---|---|
| **General** | | |
| Number of processor packages | 1 | 1 |
| Number of cores per processor | 2 | 4 |
| Number of hardware threads per core | 2 | 4 |
| Total number of processor threads in system | 2 CPU + 3 GPU | 4 CPU + 6 GPU |
| System power management policy | HP Optimized | HP Optimized |
| Processor power-saving option | AMD PowerNow!™<br>AMD Enduro™ | AMD PowerNow!<br>AMD Enduro |
| System dimensions (length x width x height) | 12.2" × 8.48" × 0.83" | 13.34" × 9.33" × 0.83" |
| System weight | 3.37 lbs. | 3.97 lbs. |
| **CPU** | | |
| Vendor | AMD | AMD |
| Name | PRO | PRO |
| Model number | A6-7050B | A10-7350B |
| Stepping | KV-A1 | KV-A1 |
| Socket type and number of pins | Socket FP3 (906) | Socket FP3 (906) |
| Core frequency (GHz) | 2.2 / 3.0 Turbo | 2.1 / 3.3 Turbo |
| L1 cache | 2 × 16 KB + 96 KB | 4 × 16 KB + 2 × 96 KB |
| L2 cache | 1,024 KB | 2 × 2,048 KB |
| L3 cache | N/A | N/A |

| System | HP EliteBook 725 G2 | HP EliteBook 745 G2 |
|---|---|---|
| **Platform** | | |
| Vendor | Hewlett-Packard | Hewlett-Packard |
| Motherboard model number | 221D | 221C |
| Motherboard chipset | AMD K15 IMC | AMD K15 IMC |
| BIOS name and version | Hewlett-Packard M84 Ver. 01.03 (07/04/2014) | Hewlett-Packard M84 Ver. 01.03 (07/04/2014) |
| **Memory module(s)** | | |
| Vendor and model number | Samsung M471B5173DB0-YK0 | Samsung M471B5173DB0-YK0 |
| Type | PC3-12800 | PC3-12800 |
| Speed (MHz) | 1,600 | 1,600 |
| Speed running in the system (MHz) | 1,600 | 1,600 |
| Timing/Latency (tCL-tRCD-tRP-tRASmin) | 11-11-11-28 | 11-11-11-28 |
| Size (MB) | 4,096 | 4,096 |
| Number of memory module(s) | 1 | 1 |
| Total amount of system RAM (GB) | 4 | 4 |
| Channel (single/dual) | Single | Single |
| **Hard disk** | | |
| Vendor and model number | Toshiba MQ01ACF050 | Toshiba MQ01ACF050 |
| Number of disks in system | 1 | 1 |
| Size (GB) | 500 | 500 |
| Buffer size (MB) | 16 | 16 |
| RPM | 7,200 | 7,200 |
| Type | SATA 3.0 Gb/s | SATA 3.0 Gb/s |
| Controller | AMD SATA Controller | AMD SATA Controller |
| Driver | AMD 1.2.1.359 (11/06/2013) | AMD 1.2.1.359 (11/06/2013) |
| **Operating system** | | |
| Name | Microsoft Windows 7 Professional x64 | Microsoft Windows 7 Professional x64 |
| Build number | 7601 | 7601 |
| Service Pack | 1 | 1 |
| File system | NTFS | NTFS |
| Kernel | ACPI x64-based PC | ACPI x64-based PC |
| Language | English | English |
| Microsoft DirectX version | DirectX 11 | DirectX 11 |

| System | HP EliteBook 725 G2 | HP EliteBook 745 G2 |
|---|---|---|
| **Graphics** | | |
| Vendor and model number | AMD Radeon R4 Graphics | AMD Radeon R6 Graphics |
| Type | Integrated | Integrated |
| Chipset | AMD Radeon R4 Graphics | AMD Radeon R6 Graphics |
| BIOS version | BR45464.001 | BR45464.001 |
| Total available graphics memory (MB) | 2,020 | 2,020 |
| Dedicated video memory (MB) | 512 | 512 |
| System video memory (MB) | 0 | 0 |
| Shared system memory (MB) | 1,508 | 1,508 |
| Resolution | 1,366 × 768 | 1,366 × 768 |
| Driver | AMD 13.352.1004.1001 (04/20/2014) | AMD 13.352.1004.1001 (04/20/2014) |
| **Sound card/subsystem** | | |
| Vendor and model number | Realtek High Definition Audio | Realtek High Definition Audio |
| Driver | Realtek 6.0.1.7255 (05/27/2014) | Realtek 6.0.1.7255 (05/27/2014) |
| **Ethernet** | | |
| Vendor and model number | Realtek PCIe GBE | Realtek PCIe GBE |
| Driver | Realtek 7.83.328.2014 (03/28/2014) | Realtek 7.83.328.2014 (03/28/2014) |
| **Wireless** | | |
| Vendor and model number | Broadcom® BCM943228HMB 802.11abgn 2x2 Wi-Fi | Broadcom BCM943228HMB 802.11abgn 2x2 Wi-Fi |
| Driver | Broadcom 6.30.223.228 (02/05/2014) | Broadcom 6.30.223.228 (02/05/2014) |
| **USB ports** | | |
| Number | 3 | 4 |
| Type | USB 3.0 | USB 3.0 |
| Other | Media card reader, Display port | Media card reader, Display port |
| **Monitor** | | |
| LCD type | HD LED | HD LED |
| Screen size | 12.5" | 14.0" |
| Refresh rate | 60 Hz | 60 Hz |
| **Battery** | | |
| Type | 3-cell Li-Polymer | 3-cell Li-Polymer |
| Size (length × width × height) | 7.47" × 3.89" × 0.32" | 7.82" × 4.04" × 0.31" |
| Rated capacity | 46 Whr | 50 Whr |
| Weight | 0.56 lb. | 0.58 lb. |

Figure 15: Detailed information for the tested AMD processor-based HP EliteBook notebooks.

# APPENDIX C – HOW WE TESTED

## HDXPRT 2012
### Setting up the test
1. Insert the HDXPRT v1.1 DVD-ROM into your DVD drive.
2. At the HDXPRT Install screen, click Install HDXPRT.
3. Accept the HDXPRT end user license agreement.
4. After the setup is complete, select Yes, I want to restart my computer now, and click Finish.

### Running the test
1. Click the HDXPRT 2012 shortcut on the desktop.
2. Click Run HDXPRT.
3. Enter a test name, choose 3 iterations, and click Run.
4. The Results Screen automatically appears at the end of a successful run. The test results files are found in the C:\Program Files\HDXPRT\Reports\<TestName> directory.

## BAPCo SYSmark 2014 v1.0.1.21
### Antivirus software conflicts
SYSmark 2014 is not compatible with any virus-scanning software, so we uninstalled any such software that was present on the notebook PCs before we installed the benchmark.

### Pre-installed software conflicts
SYSmark 2014 installs the following applications, which its test scripts employ:
- Adobe Acrobat XI Pro
- Adobe Photoshop CS6 Extended
- Adobe Premiere Pro CS6
- Google Chrome™
- Microsoft Excel 2013
- Microsoft OneNote® 2013
- Microsoft Outlook 2013
- Microsoft PowerPoint 2013
- Microsoft Word 2013
- Trimble® SketchUp® Pro 2013
- WinZip Pro 17.5

If any of these applications are already on the system under test, they will cause problems with the benchmark due to software conflicts. To avoid any such issues, before we installed the benchmark, we uninstalled all conflicting pre-installed software applications, including different versions of any of the programs SYSmark 2014 uses.

### Setting up the test
1. Disable the User Account Control.
   a. Click Start→Control Panel.
   b. At the User Accounts and Family Safety settings screen, click Add or remove user account.
   c. At the User Account Control screen, click Continue.

d.  Click Go to the main User Accounts page.

   e.  At the Make changes to your user account screen, click Turn User Account Control on or off.

   f.  At the User Account Control screen, click Continue.

   g.  Uncheck Use User Account Control to help protect your computer, and click OK.

   h.  At the You must restart your computer to apply these changes screen, click Restart Now.

2. Purchase and install SYSmark 2014 v1.0.1.21 with default settings from [www.bapco.com/products/sysmark-2014](http://www.bapco.com/products/sysmark-2014).

3. To launch SYSmark 2014, double-click the desktop icon, and select Configuration.

4. Select All Options, and click Save.

### Running the test
1. Double-click the SYSmark 2014 desktop icon.

2. Make sure Office Productivity, Media Creation, and Data/Financial Analysis are selected.

3. Enter a Project name.

4. Select 3 Iterations, check the box beside Conditioning Run and beside Process Idle Tasks, and click Run Benchmark.

5. When the benchmark completes and the main SYSmark 2014 menu appears, click Save FDR to create a report.


## 3DMark
### Installing 3DMark v1.4.778
1. Download the 3DMark benchmark from [www.futuremark.com/benchmarks/3dmark/all](http://www.futuremark.com/benchmarks/3dmark/all).

2. Install 3DMark with the default options by double-clicking the 3DMark installer.exe file.

   a.  At the Welcome screen, click Next.

   b.  At the License Agreement screen, click I accept the terms of the license agreement, and click Next.

   c.  At the Setup Type screen, click Express, and click Next.

   d.  At the Ready to Install the Program screen, click Install.

3. At the Setup Complete screen, click Finish.

4. Launch 3DMark by double-clicking on the 3DMark desktop icon. Enter the registration code, and click Register.

5. Exit 3DMark.


### Running 3DMark v1.4.778
1. Boot the system and bring up a command prompt:

   a.  Type `CMD`

   b.  Right-click the Command Prompt app to open App options.

   c.  Click the Run as administrator button.

2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`

3. Do not interact with the system until the command completes.

4. After the command completes, wait 5 minutes before running the test.

5. Double-click the 3DMark desktop icon to launch the benchmark.

6. At the 3DMark Welcome screen, click the Run primary tests button.

7. When the benchmark run completes, record the results.

8. Perform steps 1 through 7 two more times, and report the median of the three runs.

## WebXPRT 2012

### Running the test

1. Open the default Web browser, and go to www.principledtechnologies.com/benchmarkxprt/webxprt/.
2. Click Run WebXPRT 2013.
3. At the Ready to test your browser screen, click Continue.
4. Click Start.
5. When the test completes, record the results.
6. Perform steps 1 through 5 two more times, and report the median of the three runs.

## Futuremark PCMark 8 v2.2.282

### Setting up the test

1. Download the PCMark 8 installer exe Windows package from www.futuremark.com/benchmarks/pcmark8.
2. Install PCMark 8 with the default options by double-clicking the PCMark installer exe file.
3. Launch PCMark 8 by clicking on the PCMark 8 desktop icon. Enter the registration code, click Register, and click OK.
4. Exit PCMark 8.

### Running the test

1. Boot the system and bring up a command prompt:
   a. Type `CMD`
   b. Right-click the Command Prompt app to open App options.
   c. Click the Run as administrator button.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait 5 minutes before running the test.
5. Double-click the PCMark 8 desktop icon to launch the benchmark.
6. Select the Home test suite.
7. Click Run Conventional.
8. When the benchmark run completes, record the results.
9. Shut down the system.
10. Perform steps 1 through 9 two more times for the Home test suite, and report the median of the three runs.
11. After completing the three runs of the Home test suite, repeat steps 1 through 10 for the Creative, Work, Storage, and Application suites.

## Setting up the Microsoft Office tests

1. Install Microsoft Office 365™ with default options. Copy the test files to the desktop.
2. Place the Microsoft Excel Number Crunch spreadsheet in the documents folder of each system under test. This Excel spreadsheet executes approximately 28,000 sets of calculations such as addition, subtraction, division, rounding, and square root. It also includes common statistical analysis functions such as Max, Min, Median, and Average. It generates a timed score on how long the calculations took to complete.

## Crunching numbers in Microsoft Excel

1. Boot the system and bring up an administrative command prompt:
   a. Type `CMD`

b. Right-click the Command Prompt app to open App options.

c. Click the Run as administrator button.

2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
Do not interact with the system until the command completes.

3. After the command completes, wait 5 minutes before running the test.

4. Open the Microsoft Excel Number Crunch spreadsheet.

5. Press CTRL + R to start the calculation.

6. Record the output.

7. Close the Excel spreadsheet.

8. Shut down the system.

9. Perform steps 1 through 8 two more times, and report the median of the three runs.

## Launching Microsoft PowerPoint

1. Boot the system and bring up an administrative command prompt:

a. Type `CMD`

b. Right-click the Command Prompt app to open App options.

c. Click the Run as administrator button.

2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
Do not interact with the system until the command completes.

3. After the command completes, wait 5 minutes before running the test.

4. Press the Windows key.

5. Simultaneously start the timer and select Microsoft Word.

6. Stop the timer when all the Microsoft Word templates are fully displayed.

7. Close Microsoft Word.

8. Shut down the system.

9. Repeat steps 1 through 8 two more times, and report the median of the three runs.

## Launching Adobe Photoshop Elements 13 and encoding a file to JPEG

### Setting up the test

1. Download and install Photoshop Elements with default options from
   www.adobe.com/cfusion/tdrc/index.cfm?product=photoshop_elements&loc=en.

2. Copy the test Photoshop Elements test file to the desktop.

### Running the test

1. Boot the system and bring up an administrative command prompt:

a. Type `CMD`

b. Right-click the Command Prompt app to open App options.

c. Click the Run as administrator button.

2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
Do not interact with the system until the command completes.

3. After the command completes, wait 5 minutes before running the test.

4. Simultaneously double-click the Adobe Photoshop Elements test file, and start the stopwatch.

5. Stop the stopwatch when the file is loaded into Photoshop Elements.

6. Click File→Save As.

7. Select JPEG from the drop-down format menu and enter a file name.

8. Click Save.

9. In JPEG Options, slide the file size bar all the way to the right for the largest file (12).

10. Simultaneously click OK and start the stopwatch.

11. Stop the stopwatch when the progress bar disappears and the curser stops spinning.

12. Shut down the system.

13. Perform steps 1 through 12 two more times, and report the median of three runs.

## Launching Adobe Premiere Elements 13 and encoding a file to MPEG

### Setting up the test

1. Download and install Premiere Elements with default options from
   www.adobe.com/cfusion/tdrc/index.cfm?product=premiere_elements&loc=us.

2. Copy the Adobe Premiere Elements test file to the desktop.

### Running the test

1. Boot the system and bring up an administrative command prompt:

   a. Type `CMD`

   b. Right-click the Command Prompt app to open App options.

   c. Click the Run as administrator button.

2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
   Do not interact with the system until the command completes.

3. After the command completes, wait 5 minutes before running the test.

4. Simultaneously double-click the Adobe Premiere Elements test file, and start the stopwatch.

5. Stop the stopwatch when the project is loaded into Adobe Premiere Elements.

6. Click the Publish + Share tab, and select Computer.

7. Select MPEG, enter a file name, and simultaneously click Save and start the stopwatch.

8. Stop the stopwatch when the progress bar disappears and the Done button appears.

9. Shut down the system.

10. Perform steps 1 through 9 two more times, and report the median of three runs.

## Measuring battery life with MobileMark 2012

### Avoiding antivirus software conflicts

MobileMark 2012 is not compatible with any virus-scanning software, so we uninstalled any such software present on the notebook PCs before we installed the benchmark.

### Avoiding pre-installed software conflicts

MobileMark 2012 installs the following applications, which its test scripts employ:

- 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
- Microsoft Outlook 2010 SP1
- Microsoft PowerPoint 2010 SP1
- Microsoft Windows Media Player
- Microsoft Word 2010 SP1
- Mozilla Firefox 10.0.2
- WinZip Pro 16

If any of these applications are already on the system under test, they could cause problems with the benchmark due to software conflicts. To avoid any such issues, before we installed the benchmark, we uninstalled all conflicting pre-installed software applications, including different versions of any of the programs MobileMark 2012 uses.

### Adjusting display brightness and power settings

The brightness of a notebook's display affects its battery life. Therefore, BAPCo requires that, before you test with MobileMark 2012, you do the following step: make sure the brightness of the notebook's monitor is greater than or equal to 150 nits on a completely white screen while the notebook is unplugged and running on battery power. The measurement follows the standards from the Video Electronics Standards Association (www.vesa.org).

We complied with this standard for all the tests we ran by setting the notebook PC's brightness as close to 150 nits as we could without going below that brightness level. We used the following procedure before we started each test. Note: This procedure assumes we began with the notebook plugged into the power supply.

1. To create a completely blank, white screen, open Microsoft Paint by clicking Start→All Programs→ Accessories→Paint.
2. Press Ctrl+W to open the Resize and Skew dialog.
3. Under Horizontal and Vertical enter 200, and click OK.
4. Click the View tab.
5. Click Full screen to view a white screen.
6. Wait 45 minutes to allow the screen to warm.
7. Unplug the notebook from the power supply, and measure the display's brightness using a luminance meter in the center of the screen. (We used the Gossen® Mavolux5032C.)
8. If the reading is below or significantly greater than 150 nits, adjust the screen brightness to as close to 150 nits, without going under, as possible. Then retest:
   a. Click the Windows start button, and type `power options` in the Windows Start Search box.
   b. Click Change plan settings.
   c. Click Change advanced power settings.
   d. Expand the Display option, and change the Display brightness on battery and plugged in to the correct percentage that produces no less than 150 nits.
9. Allow the notebook to run on battery power for 10 minutes, re-measure the display, and adjust the brightness up or down as necessary.
10. Verify that the notebook saved the brightness setting by plugging in the system, unplugging it, and taking another reading.

## Using the MobileMark built-in Configuration Tool
This tool supports three levels of configuration:
1. Only makes changes that are REQUIRED in order for the benchmark to run.
2. Additionally, makes changes that are RECOMMENDED for repeatable results.
3. Additionally, makes OPTIONAL changes that help ensure best results.

The Configuration tool makes the following configuration changes at each of the three levels:

### Level 1 - Required
- Disables User Account Control (UAC)
- Disables Windows Update
- Disables System Sleep and Hibernate
- Sets Screen Dimming Timeout (2 minutes)
- Disables Low Battery Actions
- Disables Network Proxies
- Disables Autorun for Optical Drive

### Level 2 - Recommended
- Create BAPCo power scheme
- Set Power Plan Type to balanced
- Disables Windows Firewall
- Disables Windows Sidebar/Gadgets
- Disables Windows Pop-ups
- Disables Incoming Remote Desktop Connections
- Disables Windows Error Reporting
- Disables Screen Saver and Monitor Timeout
- Sets CPU Adaptive Mode
- Disables Desktop Slideshow
- Disables Disk Defrag

### Level 3 - Optional
- Sets Hard Disk Timeout
- Disables Windows Defender
- Disables System Restore
- Ignores Laptop Lid Close
- Sets Maximum Display Brightness
- Disables Adaptive Brightness

We chose all options listed - Level 3 - in the Configuration tool.

## Installing MobileMark 2012 and configuring the system for testing
1. Verify that the wireless adapter is enabled and connected to a wireless router that is not connected to the Internet.
2. Insert the MobileMark 2012 Install DVD into the notebook PC's DVD drive.
3. When the Autoplay menu appears, click Run MobileMark2012_Setup.exe.
4. At the Welcome screen, click Next.

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5. Enter the serial number, and click Next.
6. Accept the license agreement, and click Next.
7. At the Choose Components screen, select Full, and click Next.
8. At the Choose Install Location screen, accept the default location of C:\Program Files (x86)\BAPCo\MobileMark2012, and click Next.
9. At the Choose Start Menu Folder screen, click Install.
10. Insert Disc 2 when prompted.
11. At the InstallShield Wizard Complete screen, click Finish.
12. Launch MobileMark 2012.
13. Click Configuration and choose only the Required options.
14. Click Apply, and restart the computer when prompted.
15. Adjust the screen brightness to no less than 150 nits:
    a. Click the Windows start button, and type `power options` in the Windows Start Search box.
    b. Click Change plan settings.
    c. Click Change advanced power settings.
    d. Expand the Display option, and change the Display brightness on battery and plugged in to the correct percentage that produces no less than 150 nits.

**Conditioning the battery**
1. Plug the AC power adapter into the notebook PC, and completely charge the battery.
2. Install MobileMark 2012, following the steps we outlined in the Installing MobileMark 2012 section earlier in this section.
3. Double-click the MobileMark 2012 icon on the desktop.
4. Click the Office Productivity icon.
5. Type `System Conditioning` as the name for this test in the Project Name, check the box next to conditioning, and click Continue.
6. If MobileMark 2012 lists no problems or warnings, click Continue. If it does list any problems or warnings, close MobileMark 2012, and correct the problem(s) before proceeding.
7. When prompted, unplug the AC power adapter. The Office Productivity test begins immediately.
8. The test is complete when the notebook PC has fully depleted its battery and is no longer operational when running on battery power.
9. Plug the AC power adapter into the notebook PC, and completely charge the battery.

**Measuring battery life with MobileMark 2012**
We performed the following steps to run the MobileMark 2012 Office Productivity benchmark:
1. Double-click the MobileMark 2012 icon on the desktop.
2. Select the Office Productivity test by clicking the Office Productivity icon.
3. Enter a name for this test in the Project Name field, and click Continue.
4. If MobileMark 2012 lists no problems or warnings, click Continue. If it does list any problems or warnings, close MobileMark 2012, and correct the problem(s) before proceeding.
5. When prompted, unplug the AC power adapter. The test begins immediately.
6. The Office Productivity test is complete when the notebook PC has fully depleted its battery and is no longer operational when running on battery power.

We executed the MobileMark 2012 Office Productivity test three times on the system and took the median battery life run as the representative score for that test.

**Getting the MobileMark 2012 results**

After each MobileMark Productivity 2012 test completed, we plugged the AC power adapter into the notebook PC and turned on the system. MobileMark 2012 started automatically after the system booted, then analyzed the test scores and opened the Test Results Viewer with the results from the last test.

To submit these results to BAPCo, we saved the test results by performing the following steps:

1. Click Save.
2. Enter a name, and select FDR to save the results as an FDR file.
3. Click Save again, and select PDF to save the results as a PDF file.
4. Browse to the Documents directory where the result FDR and PDF files were saved.

# ABOUT PRINCIPLED TECHNOLOGIES

![Principled Technologies logo]

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

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

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.