



# Technical Guide

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# WHAT IS PCMARK 8?

PCMark 8 is a complete benchmark for Windows - an essential tool for testing the performance of all types of PC, from tablets to desktops, in the home and at the office.

PCMark 8 includes a variety of benchmark tests reflecting the different ways people use their computers. Each test can be run individually allowing you to choose the benchmark that best matches your own situation or the main purpose of your system.

Each benchmark produces a score you can use to compare systems as well as detailed results for gaining a deep understanding of performance during each individual workload. Scores are not comparable across tests, nor are scores from PCMark 8 comparable with results from other versions of PCMark.

Unlike previous versions of PCMark, there is no overall PCMark score. When testing devices or components, be sure to use the most appropriate benchmark for the hardware's capabilities and report your results using the full name of the test, for example:

- ✓ "Notebook scores 5,800 in PCMark 8 Creative Accelerated benchmark."
- × "Notebook scores 5,800 in PCMark benchmark."

PCMark is used by hundreds of hardware review sites and many of the world's leading manufacturers. We hope it will prove to be valuable for you as well.

## What's new in this version?

### **New Adobe and Microsoft application tests**

One of the most exciting new features in PCMark 8 is the Applications benchmark which measures system performance using popular applications from the Adobe Creative Suite and Microsoft Office such as Photoshop and Microsoft Word. You can choose which tests to run based on the applications installed on your system.

### **Battery life testing**

For the first time in the series, PCMark 8 combines performance testing with battery life measurement giving you two ways to judge the capabilities and value of a device. PCMark 8 even supports external instrumentation with 3rd party power measurement equipment.

## LATEST VERSION NUMBERS

	Version
PCMark 8 application	2.10.901
Home benchmark	3.0
Creative benchmark	3.0
Work benchmark	2.0
Storage benchmark	2.0
Applications benchmark: Microsoft Office	1.0
Applications benchmark: Adobe Creative Cloud	2.0

There are two types of version number within PCMark 8: the application version number and the benchmark version numbers.

The application version number refers to the software as a whole. It changes often as we update PCMark 8 with new features and to ensure compatibility with the latest hardware. We recommend using the latest application version.

A benchmark version number is specific to a test. For example, the Home, Creative, and Work tests each have a specific version number. Benchmark version numbers change rarely, and only when absolutely necessary to accommodate changes in third party applications or from other bug fixes.

UL guarantees that benchmark results are comparable across application versions provided that the major digit of the benchmark version number is the same. For example, Work 2.0 scores from the latest application version are comparable with Work 2.0 from previous releases. A change in the minor digit of a benchmark version number, i.e. from 1.0 to 1.1, indicates a new feature or a bug fix that does not affect the comparability of scores.

The Compatibility Mode setting in PCMark 8 Professional Edition lets you run older versions of each test if you need to compare scores with historical benchmark results.

# SYSTEM REQUIREMENTS

	Minimum	Recommended
OS	Windows 7 <sup>1</sup> (32-bit and 64-bit are supported)	Windows 7 or Windows 8 <sup>2</sup> (32-bit and 64-bit are supported)
Processor	Dual core processor	Dual core processor
Memory	2 GB	2GB
Graphics	DirectX 9 <sup>3</sup>	DirectX 11
Display	1366 × 768 resolution	1920 × 1080 resolution
Storage	30 GB free space	30 GB free space

- ⚠ Internet Explorer 10 or later required. Internet Explorer 11 recommended.
- ⚠ You must have the relevant Adobe and Microsoft applications installed in order to run the Applications tests. PCMark 8 is compatible with Adobe Creative Cloud and Microsoft Office 2010 or later.
- ⚠ An Internet connection is required for activation and some program features.

<sup>1</sup> For Windows 7, SP1 (recommended) or at least Windows Updates [KB-2729094](#), [KB-2731771](#), [KB-2533623](#), [KB-2670838](#) and [KB-2786081](#) are required.

<sup>2</sup> Users of Windows 8 N Edition and Windows 8 KN Edition will need to install [Windows Media Player 12](#).

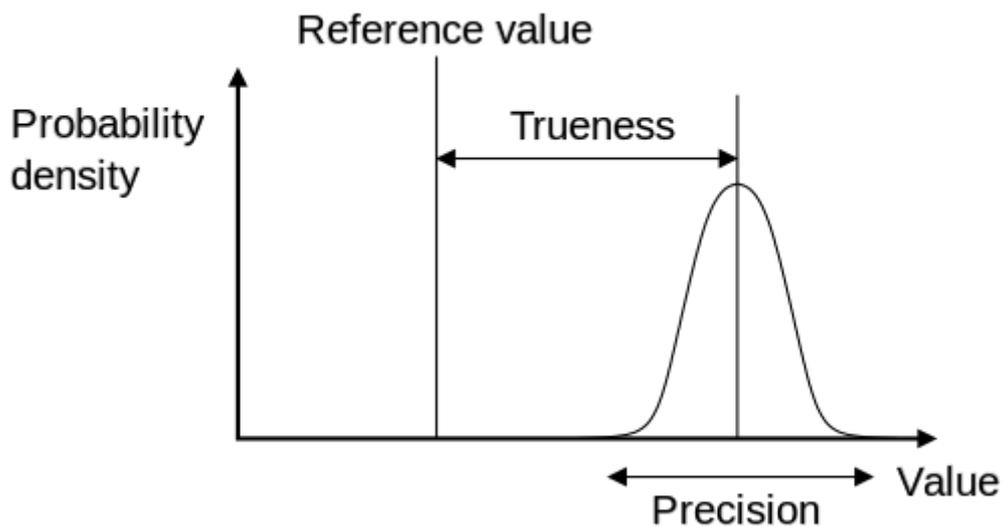
<sup>3</sup> DirectX 9 hardware needs Shader Model 2.0 support and 128MB of video RAM. PCMark 8 Creative benchmark requires hardware that supports all DirectX 11 features.

## BENCHMARK ACCURACY

The accuracy of a measurement method can be described with *trueness* and *precision*, (as defined in [ISO 5725-1](#)).

Trueness refers to the closeness of agreement between the arithmetic mean of a large number of test results and the true or accepted reference value.

Precision refers to the closeness of agreement between test results.



The precision of PCMark 8 scores is usually better than 3%. This means that running the benchmark repeatedly on a consistently performing system in a well-controlled environment will produce scores that fall within a 3% range.

Individual scores may occasionally fall outside the margin of error since the factors that influence the score cannot be completely controlled in a modern, multitasking operating system. There are also devices that simply do not offer consistent performance due to their design. In these cases, it is necessary to run the benchmark multiple times, and then take either an average or a mode of the results.

# HOW TO BENCHMARK PERFORMANCE

In general, you should benchmark every device you test under the same conditions. For example, you should test every system in the same location, at room temperature, and away from direct sunlight and other heat sources.

## Recommended process

1. Install all critical updates to ensure your operating system is up to date.
2. Install the latest approved drivers for your hardware.
3. Close other programs.
4. Run the benchmark.

## Expert process

1. Install all critical updates to ensure your operating system is up to date.
2. Install the latest approved drivers for your hardware.
3. Restart the computer or device.
4. Wait 2 minutes for startup to complete.
5. Close other programs, including those that may be running in the background.
6. Wait for 15 minutes.
7. Run the benchmark.
8. Repeat from step 3 at least three times to verify your results.

# HOW TO BENCHMARK BATTERY LIFE

Measuring performance and battery life provides a better view of the overall profile of a device than benchmarking performance alone. You can test a device's battery life using the Home, Creative, Work and Applications benchmarks in PCMark 8.

The battery must be at least 80% charged before the test will start. The test loops the benchmark until the battery charge drops below 20%. The reported battery life is an estimate for a 95% duty cycle (from 100% charged to 5%) extrapolated from the actual, measured battery life during the benchmark run.

At 20% battery charge level, warnings and pop-up alerts instruct the user to connect a power source. As such, we consider 20% charge to be the lower limit of comfortable use.

Battery life testing can take several hours during which you will not be able to use your device for other tasks. Do not use the charging cable while the test is running.

## Windows Power Plan settings

We do not recommend changing the Power Plan setting in the Windows Control Panel when benchmarking battery life. Instead, one should use the configuration that is shipped to and used by the end user. You should make a note of Power Plan used, though, to be able compare devices fairly.

## Calibrate the battery

When a device is brand new, or is usually connected to a power supply and hasn't been discharged for a long time, or has been shut down and disconnected from power for a month or more, you must calibrate its battery before running the test.

You can calibrate the device's battery with a full drain/charge cycle followed by a couple of hours left connected to mains power. For better accuracy, we recommend two complete drain/charge cycles. The device manufacturer may provide special software to calibrate the battery. Check with the manufacturer for details.

## Screen brightness settings

Screen brightness can have a significant effect on a device's battery life. To produce comparable results you should calibrate every device you test to

the same screen brightness. In practice, this is difficult without expensive, specialist equipment.

PCMark 8 provides a pure white calibration screen to help you calibrate the brightness. If you don't have access to a luminance meter, you can calibrate your devices by comparing the pure white calibration screen to a reference such as a monitor, light-box or similar. Alternatively, place your devices side by side and adjust the brightness levels by eye.

 It is not a good idea to calibrate the screen using the device's built-in brightness settings. Different screens offer different levels of maximum brightness. The 50% brightness setting on one device may not be equal in luminance to the 50% setting on another device, for example.

## Recommended process

1. Test the device at room temperature, away from direct sunlight and heat sources.
2. Disable automatic screen brightness adjustment.
3. Use the pure white calibration screen in PCMark 8 to set the device's screen brightness to a defined level, ideally 110 cd/m<sup>2</sup>.

## Expert process

To produce accurate, comparable results you should test devices under controlled conditions. Our recommendations below match those given in the [ECMA-383](#) standard "Measuring the Energy Consumption of Personal Computing Products."

1. Test the device in an environment that meets ECMA-383 requirements:
  - 1.1 Temperature: 23 +/- 5 degrees Celsius.
  - 1.2 Relative humidity: 10 - 80 %.
  - 1.3 Ambient light: 250 +/- 50 lux.
2. Disable automatic screen brightness adjustment.
3. Use the pure white calibration screen in PCMark 8 and a luminance meter to calibrate the screen brightness to 110 cd/m<sup>2</sup>.

 Luminance is occasionally expressed in Nits. Nit is a non-SI name used for units of luminance and is equivalent to the SI unit, i.e. 1 nit = 1 cd/m<sup>2</sup>.

# PCMARK 8 SETTINGS

The settings found on the Help tab apply to all PCMark 8 benchmark tests.

## **Register / Unregister**

If you have a PCMark 8 Advanced or Professional Edition upgrade key, copy it into the box and press the Register button. If you wish to unregister your key, so you can move your license to a different machine for example, press the Unregister button.

## **Automatically view results online**

When this box is checked PCMark 8 will automatically open a browser window allowing you to view your results on the UL website after you complete a benchmark run. This option is selected by default and cannot be disabled in PCMark 8 Basic Edition.

## **Enable compatibility mode**

Check this box if you wish to run benchmark tests from a previous version of PCMark 8, for instance to compare a system against a historical set of test results. This option is disabled by default and cannot be selected in PCMark 8 Basic Edition.

## **Scan SystemInfo**

SystemInfo is a component used in UL benchmarks to identify the hardware in your system or device. It does not collect any personally identifiable information. This option is selected by default and is required in order to get a valid benchmark test score.

## **SystemInfo monitoring**

This option controls whether SystemInfo monitors your CPU temperature, clock speed, power, and other hardware information during the benchmark run. This option is selected by default.

## **Automatically detect 3<sup>rd</sup> party applications**

When this option is selected, PCMark 8 will look in the default install locations for 3<sup>rd</sup> party applications such as Internet Explorer, Microsoft Office and Adobe Creative Suite. This option is selected by default.

## **Enable hardware accelerated video transcoding and playback**

This option allows media workloads to use hardware acceleration, if available. This option is selected by default.

### **Maximum logging**

This option is disabled by default since it can affect performance. You should only use this option when instructed to by UL as part of resolving a support request.

### **Override automatic OpenCL selections**

PCMark 8 will automatically choose the optimal OpenCL device in your system when running benchmark tests in Accelerated mode. For troubleshooting, or comparison testing, you can override the automatic selection and choose the OpenCL device manually.

### **Reset all settings and options**

This button restores all settings and options to their defaults.

# HOME BENCHMARK

PCMark 8 Home benchmark measures your system's ability to perform a series of common tasks typical of daily home use. The Home workloads generally have light computational requirements and are ideal for testing low-cost tablets, notebooks and desktop home PCs.

The PCMark 8 Home benchmark test contains the following workloads.

- [Web Browsing](#)
- [Writing](#)
- [Casual Gaming](#)
- [Photo Editing](#)
- [Video Chat](#)

Please refer to the Workloads section for a detailed description of each workload.

## Run Conventional

In Conventional mode the workloads do not use OpenCL. This reflects how the majority of software works today, with the score providing a performance baseline.

## Run Accelerated

Accelerated mode allows workloads to use OpenCL acceleration, anticipating the way software will work in the future. PCMark 8 will automatically find and use the optimal OpenCL device in your system.

 While you can compare Conventional and Accelerated scores from a single system, you should not compare Conventional scores from one system with Accelerated scores from another system. When comparing two or more systems, you should use the same mode on every system being tested.

# HOME BENCHMARK VERSION HISTORY

Version	Release date	Notes
3.0	January 17, 2014	New Photo Editing test using the open source ImageMagick library and a wider variety of image processing operations. Video Chat test now features improved face detection and performance. The test has been updated to use OpenCV 2.4.7.
2.0	October 10, 2013	Added Conventional and Accelerated run modes. Professional Edition only. <sup>4</sup>
1.0	May 31, 2013	Launch version, Professional Edition only

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<sup>4</sup> PCMark 8 Basic and Advanced Editions were released on October 21, 2013 with the Home 2.0 workload.

# CREATIVE BENCHMARK

PCMark 8 Creative benchmark measures your system's ability to perform a series of entertainment and media tasks. The Creative workloads generally have demanding computational requirements and are designed for testing mid to high-end notebooks and desktops. Your system must have a GPU with full DirectX 11 support in order to run all the workloads in the PCMark 8 Creative benchmark.

The PCMark 8 Creative benchmark test contains the following workloads:

- [Web Browsing](#)
- [Photo Editing](#)
- [Batch Photo Editing](#)
- [Video Editing](#)
- [Media To Go](#)
- [Mainstream Gaming](#)
- [Video Group Chat](#)

Please refer to the Workloads section for a detailed description of each workload.

## Run Conventional

In Conventional mode the workloads do not use OpenCL. This reflects how the majority of software works today, with the score providing a performance baseline.

## Run Accelerated

Accelerated mode allows workloads to use OpenCL acceleration, anticipating the way software will work in the future. PCMark 8 will automatically find and use the optimal OpenCL device in your system.

 While you can compare Conventional and Accelerated scores from a single system, you should not compare Conventional scores from one system with Accelerated scores from another system. When comparing two or more systems, you should use the same mode on every system being tested.

# CREATIVE BENCHMARK VERSION HISTORY

Version	Release date	Notes
3.0	January 17, 2014	New Photo Editing test using the open source ImageMagick library and a wider variety of image processing operations. Video Editing part 2 now uses source material in 4K UHD resolution (3840 × 2160). Video Group Chat test now features improved face detection and performance. The test has been updated to use OpenCV 2.4.7.
2.0	October 10, 2013	Added Conventional and Accelerated run modes. Professional Edition only. <sup>5</sup>
1.0	May 31, 2013	Launch version, Professional Edition only

---

<sup>5</sup> PCMark 8 Basic and Advanced Editions were released on October 21, 2013 with the Creative 2.0 workload.

# WORK BENCHMARK

PCMark 8 Work benchmark measures your system's ability to perform a series of basic office and work tasks. For more demanding office use, run the Creative benchmark test. The Work tests are designed for testing typical office notebooks and desktop PCs that lack media capabilities.

The PCMark 8 Work benchmark test contains the following workloads:

- [Web Browsing](#)
- [Writing](#)
- [Video Chat](#)
- [Spreadsheet](#)

Please refer to the Workloads section for a detailed description of each workload.

## Run Conventional

In Conventional mode the workloads do not use OpenCL. This reflects how the majority of software works today, with the score providing a performance baseline.

## Run Accelerated

Accelerated mode allows workloads to use OpenCL acceleration, anticipating the way software will work in the future. PCMark 8 will automatically find and use the optimal OpenCL device in your system.

 While you can compare Conventional and Accelerated scores from a single system, you should not compare Conventional scores from one system with Accelerated scores from another system. When comparing two or more systems, you should use the same mode on every system being tested.

# WORK BENCHMARK VERSION HISTORY

Version	Release date	Notes
2.0	January 17, 2014	New Spreadsheet test using LibreOffice Calc, a part of the open-source productivity suite from The Document Foundation. Added Video Chat test.
1.0	May 31, 2013	Launch version, Professional Edition only

# STORAGE BENCHMARK

PCMark 8 Storage benchmark is ideal for testing the performance of SSDs, HDDs and hybrid drives.

Using traces recorded from Adobe Creative Suite, Microsoft Office and a selection of popular games, PCMark 8 Storage highlights real-world performance differences between storage devices. You do not need to have these applications installed on your system to run the Storage benchmark.

The PCMark 8 Storage benchmark test contains the following workload traces:

- [Storage – Adobe Photoshop light](#)
- [Storage – Adobe Photoshop heavy](#)
- [Storage – Adobe Illustrator](#)
- [Storage – Adobe InDesign](#)
- [Storage – Adobe After Effects](#)
- [Storage – Microsoft Word](#)
- [Storage – Microsoft Excel](#)
- [Storage – Microsoft PowerPoint](#)
- [Storage – World of Warcraft](#)
- [Storage – Battlefield 3](#)

Please refer to the Workloads section for a detailed description of each workload.

# EXPANDED STORAGE

PCMark 8 Expanded Storage benchmarks are specialist tests designed for professional testing labs. These benchmarks are only available from the command line with PCMark 8 Professional Edition. You can download the [PCMark 8 Command Line Guide](#) from the UL Benchmarks website.

PCMark 8 v2.3.293 added the ability to customize the Storage Consistency test. You'll find details and instructions in the [PCMark 8 Storage Consistency Customization Guide](#).

Please refer to the [Workloads](#) section for a detailed description of each test.

 These tests can take up to 24 hours or more to complete.

## How to prepare a drive for Expanded Storage tests

PCMark 8 Expanded Storage tests can only be run on a completely clean drive. To protect against accidental data loss, PCMark 8 will refuse to run the Expanded Storage tests on a disk that has partitions defined in the partition table. To clean and prepare a drive for the Expanded Storage tests:

- Run DISKPART from an elevated (admin) command line
- Type `list disk`
- Type `select disk n`, where n is the number of the disk to test
- Type `clean` to fully erase the drive
- Exit DISKPART

## Adaptivity test

The Adaptivity test measures the "learning" capabilities of the storage system.

The Storage test workloads are repeated and the results are observed. The test continues until a steady state of performance has been reached.

The benchmark reports the performance level at the start and in the steady state as well as the number of iterations required to reach the state.

## Consistency test

The PCMark 8 Consistency test measures the performance consistency and degradation tendency of a storage system.

The Storage test workloads are repeated. Between each repetition the storage system is bombarded with a usage that causes degraded drive performance.

In the first part of the test, the cycle continues until a steady degraded level of performance has been reached.

In the second part, the recovery of the system is tested by allowing the system to idle and measuring the performance with long intervals.

The test reports the performance level at the start, the degraded steady-state and the recovered state as well as the number of iterations required to reach the degraded state and the recovered state.

# STORAGE BENCHMARK VERSION HISTORY

Version	Release date	Notes
2.0	January 18, 2016	The test now provides better support for NVMe drives. Scores from NVMe drives will improve in some cases. The faster the drive, the bigger the difference. Other types of drive are unaffected.
1.1	November 27, 2014	A bug fix in this application update means that scores from the Expanded Storage tests included in PCMark 8 Professional Edition may improve slightly on some hardware. The main Storage benchmark score is not affected.
1.1	January 17, 2014	Added Expanded Storage tests for specialist analysis of drive performance. PCMark 8 Professional Edition command line only.
1.0	May 31, 2013	Launch version, Professional Edition only

# APPLICATIONS BENCHMARKS

The PCMark 8 Applications benchmark measures system performance using popular applications from the Adobe Creative Cloud and Microsoft Office. You can choose which tests to run based on the applications installed on your system. Each test automatically steps through a series of actions such as opening, editing and saving a file. The results are used to calculate the PCMark 8 Applications scores for the system.

PCMark 8 is compatible with Adobe Creative Cloud and Microsoft Office 2010 or later. You must have the relevant Adobe and Microsoft applications installed in order to run the PCMark 8 Applications test.

 When comparing two or more systems, ensure you are using the same versions of the third party applications on every system being tested.

## ADOBE CREATIVE CLOUD TEST (2.0)

The test uses the following workloads:

- [Adobe Photoshop light](#)
- [Adobe Photoshop heavy](#)
- [Adobe InDesign](#)
- [Adobe Illustrator](#)
- [Adobe After Effects CC](#)

Please refer to the Workloads section for a detailed description of each workload.

# MICROSOFT OFFICE TEST

PCMark 8 is compatible with Microsoft Office 2010 and Microsoft Office 2013. The Microsoft Office test consists of following subtests:

- [Microsoft Word](#)
- [Microsoft Excel](#)
- [Microsoft PowerPoint](#)

Please refer to the Workloads section for a detailed description of each workload.

# APPLICATIONS BENCHMARK VERSION HISTORY

## Adobe Creative Cloud benchmark

Version	Release date	Notes
2.0	January 18, 2016	The After Effects test output has been changed to uncompressed AVI format as the latest version of Adobe After Effects CC no longer supports output to compressed Windows Media Video format.
1.0	May 31, 2013	Launch version

 Enable [Compatibility Mode](#) to use version 1.0 of the test with Adobe Creative Suite 6 or with Adobe Creative Cloud applications from 2014 or before. Scores from 2.0 and 1.0 are not comparable.

## Applications benchmark: Microsoft Office version history

Version	Release date	Notes
1.0	May 31, 2013	Launch version

# BATTERY LIFE TESTING

PCMark 8 improves on previous versions by including new battery life testing tools. Choosing Battery Life mode before running the Home, Creative, Work or Applications benchmark will loop the test until the battery is almost empty to accurately measure battery life under real-world conditions.

The device's battery must be at least 80 percent charged before Battery Life testing can begin. The test will end when the battery level falls below 20 percent.

# TUNING

From the Tuning tab you can select and run individual workloads from any of the benchmarks in PCMark 8. This can be useful for fine-tuning settings or troubleshooting hardware issues.

Running one or more workloads from the Tuning tab will produce detailed results for each workload, but will not produce an overall benchmark score, even if all the workloads required for the benchmark were included in the run.

# BENCHMARK WORKLOADS

# WEB BROWSING - JUNGLEPIN

Components stressed by this workload CPU, storage system

Benchmarks that use this test Home, Creative, Work

## Implementation

This workload represents a common web browsing scenario: checking up on friends on a social networking site.

The workload launches a web browser application and loads the workload content. The web browser is a custom-built application utilizing the Internet Explorer ActiveX control using IWebBrowser2 interface. The web server is a local server built into the test application.

## Tasks

1. renderitems: renders a page with varying sized images, measures time
2. scroll: scrolls the page down and back to up, measures frame rate
3. openitem: zooms into one picture, measures animation frame rate
4. opensearch: loads a set of data into search feature, measures time
5. writesearch: executes searches when a search term typed a character in time, measures time
6. additemanimation: selects a thumbnail area from image to be added, measures animation frame rate
7. additem: adds the image to page causing re-rendering the page, measures time

## Summary

	Total files	Package size
Initial document	178	4.4 MB

## Scoring

$$\text{Primary result} = \text{GEOMEAN}\left(\frac{1}{R_1}, \frac{1}{R_2}, R_3, R_4\right)$$

Where

$R_1 = \text{addanimation\_result}$  secondary result

$R_2 = \text{openitem\_result}$  secondary result

$R_3 = \text{scroll\_latency}$  secondary result

$R_4 = \text{writesearch\_latency}$  secondary result

# WEB BROWSING - AMAZONIA

Components stressed by this workload CPU, storage system

Benchmarks that use this test Home, Creative, Work

## Implementation

This workload represents a common web browsing scenario: checking up on friends on a social networking site and searching for items from an online retailer.

The workload launches a web browser application and loads the workload content. The web browser is a custom-built application utilizing the Internet Explorer ActiveX control using IWebBrowser2 interface. The web server is a local server built into the test application.

## Tasks

1. scroll: scrolls the page down and back to up, measures frame rate
2. animation: animates a product 360 degrees image, measures frame rate
3. carousel: animates the product carousel when different products are selected, measures frame rate
4. addtocart: adds a product to shopping cart, measures time

## Scoring

$$\text{Primary result} = \text{GEOMEAN}\left(\frac{1}{R_1}, \frac{1}{R_2}, R_3\right)$$

Where:

$R_1$  = **itemanimation\_result** secondary result

$R_2$  = **carousel\_result** secondary result

$R_3$  = **scroll\_latency** secondary result

# WRITING

Components stressed by this workload CPU, storage system

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Benchmarks that use this test Home, Work

## Implementation

This workload represents basic word processing activity. The test uses a custom text editor written in C# for .NET Framework 4.5. The workload stresses the Microsoft Rich Edit control.

The workload steps through a series of common word processing tasks, recording the time taken to complete each task.

### Tasks

1. Load Document 1, display in a window
2. Load Document 2, display in a window
3. Copy a large part of Document 1 and paste into Document 2
4. Save As with Document 2
5. Resize Document 2 window
6. Cut and paste parts of Document 2 around within the document
7. Save Document 2
8. Type some text in Document 2
9. Save Document 2
10. Insert some pictures from a local drive in Document 2
11. Save Document 2

### Summary

	File size	Pages	Word count	Images
Initial document	53.5 MB	73	17,801	5
Final document	67.2 MB	110	30,587	10

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10}, R_{11})$$

Where:

$R_1$  = source\_document\_display\_time secondary result

$R_2$  = destination\_document\_display\_time secondary result

$R_3$  = copy\_and\_paste\_time secondary result

$R_4$  = save\_target\_document\_1\_time secondary result

$R_5$  = resize\_target\_document\_window\_time secondary result

$R_6$  = cut\_and\_paste\_time secondary result

$R_7$  = save\_target\_document\_2\_time secondary result

$R_8$  = type\_text\_to\_destination\_document\_time secondary result

$R_9$  = save\_target\_document\_3\_time secondary result

$R_{10}$  = add\_pictures\_to\_destination\_document secondary result

$R_{11}$  = save\_target\_document\_4\_time secondary result

# CASUAL GAMING

Components stressed by this workload CPU, GPU

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Benchmarks that use this test Home

## Implementation

The workload represents the demands of a casual DirectX 9 game with 3D graphics using ShaderModel 2.0 capable hardware delivers a high and consistent frame rate.

This workload uses the Firefly test that first appeared in 3DMark06 and has since been used as the DirectX 9 graphics test in PCMark Vantage and PCMark 7. More details can be found in the [3DMark06 Technical Guide](#).

In this workload a forest is inhabited by magic fireflies that playfully fly around the forest. There are a large number of trees with branches swaying separately in the light breeze, and there is dense vegetation on the ground. The vegetation is dynamically distributed according to the camera movements. The level of detail is also dynamically altered depending on the distance to the camera.

The ground material uses diffuse, diffuse detail, normal and normal detail maps. The rock surfaces also have a specular map. The tree branches are also a modified material without a specular map and with a diffuse cube map and no bump mapping. The sky is created using a procedural light scattering shader.

The moonlight is directional, generating cascading shadow maps. The illuminating fireflies are shadow mapped point lights with a cubemap mask. The illuminating fireflies are masked point lights, throwing shadows using a  $1024 \times 1024 \times 6$  cube depth map/hardware shadow maps.

## Scoring

The primary result is the average frames per second during the test.

# MAINSTREAM GAMING

Components stressed by this workload CPU, GPU

Benchmarks that use this test Creative

---

## Implementation

This workload represents the demands of modern mainstream DirectX 11 video games. Powerful hardware delivers a high and consistent frame rate.

The workload uses Graphics tests 3 and 4 from 3DMark 11. The tests run at 1280 × 720 in windowed mode otherwise the settings are the same used in the 3DMark 11 Performance preset. More details can be found in the [3DMark 11 Technical Guide](#).

### Part 1

PCMark 8 Mainstream Gaming part 1 uses the same workload as 3DMark 11 Graphics test 3 running under the Performance preset.

The workload renders a scene with one shadow casting directional light and a moderate number of non-shadow casting point lights. Volumetric illumination is only enabled for the shadow casting directional light. The shadow casting directional light uses volumetric illumination with optical density varied along world space height. The scene contains tessellated geometry.

### Part 2

PCMark 8 Mainstream Gaming part 2 uses the same workload as 3DMark 11 Graphics test 4 running under the Performance preset.

The workload renders a scene with one shadow casting directional light and a few shadow casting spot lights is rendered. The scene uses volumetric illumination with optical density varied along world space height. Majority of the rendering workload comes from drawing tessellated geometry to shadow maps and G-buffer.

## Scoring

The primary result is the average frames per second during the test.

# PHOTO EDITING V2 IN HOME 3.0, CREATIVE 3.0

Components stressed by this workload CPU, GPU (with OpenCL)

Benchmarks that use this test Home, Creative

## Implementation

This workload involves making a series of adjustments to a set of photographs using [ImageMagick](#), an open source image processing library. When a favorable balance is found, the changes are applied to the rest of the images in the set.

### Tasks

1. Load all thumbnails into a previewing matrix
2. Load and display a source image into the adjustment view
3. Apply brightness, contrast, saturation, unsharp mask, Gaussian noise, Gaussian blur and a further unsharp mask to the source image and display the resulting image in the adjustment view, repeating the adjustment 20 times via sliders.

### Summary

	Images	File sizes	Resolution
Source files	32 TIFF	4.7-52.3 MB	2674 × 1506
			8576 × 5696
Final files	32 TIFF	6.3-66.7 MB	2674 × 1506
			8576 × 5696

### Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6)$$

Where

- $R_1$  = load\_image\_matrix\_time
- $R_2$  = color\_adjusting\_step\_latency
- $R_3$  = unshap\_mask\_1\_step\_latency
- $R_4$  = noise\_adding\_latency
- $R_5$  = gaussian\_blur\_step\_latency

$R_6 = \text{unshap\_mask\_2\_step\_latency}$

# PHOTO EDITING IN HOME 2.0, CREATIVE 2.0 (COMPATIBILITY MODE)

Components stressed by this workload CPU, GPU if accelerated in GDI+

---

Benchmarks that use this test Home, Creative

## Implementation

This workload involves making a series of adjustments to a set of photographs using an image editing tool to adjust brightness, contrast, saturation and gamma. When a favorable balance is found, the changes are applied to the rest of the images in the set.

The test uses .NET 4.5 System.Drawing.Imaging API based on GDI+.

## Tasks

1. Load all thumbnails into a previewing matrix
2. Load and display a source image into the adjustment view
3. Apply a color transformation to the source image and display the resulting image in the adjustment view, repeating the adjustment 20 times via sliders.

## Summary

	Images	File sizes	Resolution
Source files	32 TIFF	4.7-52.3 MB	2674 × 1506 8576 × 5696
Final files	32 TIFF	6.3-66.7 MB	2674 × 1506 8576 × 5696

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3)$$

Where:

- $R_1$  = thumbnail\_loading\_time secondary result
- $R_2$  = adjustment\_startup\_time secondary result
- $R_3$  = adjustment\_time secondary result

# BATCH PHOTO EDITING V2 IN CREATIVE 3.0

Components stressed by this workload CPU, GPU (with OpenCL)

---

Benchmarks that use this test Creative

## Implementation

This workload involves making a series of adjustments to a set of photographs using [ImageMagick](#), an open source image processing library. When a favorable balance is found, the changes are applied to the rest of the images in the set.

## Tasks

1. Load all thumbnails into a preview matrix.
2. Apply brightness, contrast, saturation, unsharp mask, Gaussian noise, Gaussian blur and a further unsharp mask to the source image and display the resulting image in the adjustment view, repeating the adjustment 20 times via sliders.

## Summary

	Images	File sizes	Resolution
Source files	32 TIFF	4.7-52.3 MB	2674 × 1506 8576 × 5696
Final files	32 TIFF	6.3-66.7 MB	2674 × 1506 8576 × 5696

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2)$$

Where:

$R_1$  = load\_image\_matrix\_time secondary result  
 $R_2$  = batch\_transforming\_time secondary result

# BATCH PHOTO EDITING IN CREATIVE 2.0 (COMPATIBILITY MODE)

Components stressed by this workload CPU, GPU if accelerated in GDI+

---

Benchmarks that use this test Creative

## Implementation

This workload involves making a series of adjustments to the brightness, contrast, saturation and gamma settings for a large set of photographs using batch processing. The test uses .NET 4.5 System.Drawing.Imaging API based on GDI+.

## Tasks

1. Load all thumbnails into a preview matrix.
2. Apply color transformation parameters to all of the original images and save the resulting transformed images to disk.

## Summary

	Images	File sizes	Resolution
Source files	32 TIFF	4.7-52.3 MB	2674 × 1506 8576 × 5696
Final files	32 TIFF	6.3-66.7 MB	2674 × 1506 8576 × 5696

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_4)$$

Where:

$R_1$  = thumbnail\_loading\_time secondary result

$R_4$  = batch\_transformation\_time secondary result

# VIDEO EDITING V2 IN CREATIVE 3.0

Components stressed by this workload CPU, GPU (with OpenCL)

Benchmarks that use this test Creative

## Implementation

The workload uses [FFmpeg](#) to apply video enhancement filters to a high bitrate H.264 video and then encode it to a format suitable for distribution.

The FFmpeg binary used is custom built by UL using a development version of the source available from the project's code repository. Build options are as default except that OpenCL is enabled.

### Part 1

The workload applies a deshaking filter to a source video at 1920 × 1080 (HD 1080) before scaling down and outputting at 1280 × 720 (HD 720).

Command line:

```
FFmpeg.exe -y -v 40 -i videotest_shakycamera.mp4 -vf "scale=w=1280:h=720:flags=bicubic,unsharp=opencl=%OCL%:lx=7:ly=7:la=0.56:cx=7:cy=7:ca=0.28" -strict -2 -preset superfast -tune ssim -x264opts ssim output.mp4
```

### Part 2

The workload applies a deshaking filter to a source video at 3840 × 2160 (4K UHD) before scaling down and outputting at 1920 × 1080 (HD 1080).

Command line:

```
FFmpeg.exe -y -v 40 -i videotest_shakycamera_4k.mp4 -vf deshake=opencl=%OCL%:search=1:blocksize=32,crop=in_w-192:in_h-108,scale=w=1920:h=1080 -strict -2 -vcodec libx264 -preset superfast -tune ssim -x264opts ssim output.mp4
```

## Scoring

Video editing part 1 primary result = runtime in seconds

Video editing part 2 primary result = runtime in seconds

# VIDEO EDITING IN CREATIVE 2.0 (COMPATIBILITY MODE)

Components stressed by this workload      CPU and GPU depending on OpenCL setup

---

Benchmarks that use this test              Creative

## Implementation

The workload uses [FFmpeg](#) to apply video enhancement filters to a high bitrate H.264 1080p video and then encode it to a format suitable for distribution.

The FFmpeg binary used is custom built by UL using a development version of the source available from the project's code repository. Build options are as default except that OpenCL is enabled.

### Part 1

The workload applies a deshaking filter to the video and encodes the output to H.264 1080p.

Command line:

```
FFmpeg.exe -y -v 40 -i input.mp4 -vf  
deshake=opengl=%OCL%:search=1:blocksize=32,crop=in_w-192:in_h-108 -  
strict -2 -vcodec libx264 -preset superfast -tune ssim -x264opts ssim  
output.mp4
```

### Part 2

The workload blurs, scales down and sharpens the video to H.264 720p resolution.

Command line:

```
FFmpeg.exe -y -v 40 -i input.mp4 -vf  
"smartblur=lr=2:ls=1:lt=15:cr=2:cs=0.7:ct=15,scale=w=1280:h=720,unsharp  
=lx=5:ly=5:la=2:cx=5:cy=5:ca=2" -strict -2 -preset superfast -tune ssim  
-x264opts ssim output.mp4
```

## Scoring

Video editing part 1 primary result = runtime in seconds

Video editing part 2 primary result = runtime in seconds

# MEDIA TO GO

Components stressed by this workload	CPU, GPU or custom hardware depending on the Windows Media Foundation encoders
Benchmarks that use this test	Creative

## Implementation

This workload includes three parts based on converting and syncing music and video files from a PC to a portable device. The tests implement a straightforward transcoding task using the Fast Transcode feature found in Windows Media Foundation. The number of input files is fixed in all tests.

### Music To Go

Audio to go transcodes a batch of songs in WAV format to 130 kbps AAC. The test runs transcoding in parallel with the number of worker threads equal to the number of logical cores in the CPU.

	Files
Source WAV	32
Final AAC	32

### Video To Go part 1

Video to go 720p downscales a batch of video clips in H264 1080p format to H264 720p. The workload runs in one worker thread.

	Files	Resolution	Bitrate
Source video	5	1920 × 1080	25 Mbps
Final video	5	1280 × 720	5 MBps

### Video To Go part 2

Video to go 1080p reduces the bitrate of a batch of video clips in H264 1080p format. The workload runs in one worker thread.

	Files	Resolution	Bitrate
Source video	5	1920 × 1080	25 Mbps
Final video	5	1920 × 1080	8 MBps

## Scoring

Music To Go primary result = runtime in seconds

Video To Go part 1 primary result = runtime in seconds

Video To Go part 2 primary result = runtime in seconds

# VIDEO CHAT V2 IN HOME 3.0, WORK 2.0

Components stressed by this workload	CPU, GPU or custom hardware depending on the Windows Media Foundation encoders and the OpenCL setup
Benchmarks that use this test	Home, Work

## Implementation

The workload is based on a person-to-person video chat application that displays two video streams, one incoming and one outgoing, and encodes the outgoing stream in the background.

Media playback and encoding are based on Windows Media Foundation. The incoming stream is, in practice, a local H.264 720p video played back in a window. The outgoing stream features face detection by using OpenCV to draw a rectangle around the speaker's face.

This version of the workload uses a preprocessing step (CLAHE filtering) to improve face detection and performance. The test has also been updated to use OpenCV 2.4.7.

The source content is a 1 second buffer (30 frames) of raw video to simulate a web cam. The destination of the encoded video is a memory buffer that discards frames to simulate output to a network.

## Scoring

Video chat primary result for video playback =  $R_1 / R_2$

Where:

$R_1 = \text{frames}$

$R_2 = \text{ticks}$

Video chat primary result for video encoding =  
sink\_average\_time\_per\_frame secondary result

# VIDEO CHAT IN HOME 2.0 (COMPATIBILITY MODE)

Components stressed by this workload	CPU, GPU or custom hardware depending on the Windows Media Foundation encoders and the OpenCL setup
Benchmarks that use this test	Home, Work

## Implementation

The workload is based on a person-to-person video chat application that displays two video streams, one incoming and one outgoing, and encodes the outgoing stream in the background.

Media playback and encoding are based on Windows Media Foundation. The incoming stream is, in practice, a local H.264 720p video played back in a window. The outgoing stream features face detection using an open source library called OpenCV that draws a rectangle around the speaker's face.

The source content is a 1 second buffer (30 frames) of raw video to simulate a web cam. The destination of the encoded video is a memory buffer that discards frames to simulate output to a network.

## Scoring

Video chat primary result for video playback =  $R_1 / R_2$

Where:

$R_1$  = frames

$R_2$  = ticks

Video chat primary result for video encoding =  
sink\_average\_time\_per\_frame secondary result

# VIDEO GROUP CHAT V2 IN CREATIVE 3.0

Components stressed by this workload	CPU, GPU or custom hardware depending on the Windows Media Foundation encoders and the OpenCL setup
Benchmarks that use this test	Creative

## Implementation

The workload is based on a group video chat application that displays three incoming video streams and one outgoing, which is encoded in the background.

Media playback and encoding are based on Windows Media Foundation. The incoming stream is, in practice, a local H.264 720p video played back in a window. The outgoing stream features face detection by using OpenCV to draw a rectangle around the speaker's face.

This version of the workload uses a preprocessing step (CLAHE filtering) to improve face detection and performance. The test has also been updated to use OpenCV 2.4.7.

The source content is a 1 second buffer (30 frames) of raw video to simulate a web cam. The destination of the encoded video is a memory buffer that discards frames to simulate output to a network.

## Scoring

Video group chat primary result for video playback =  $R_1 / R_2$

Where:

$R_1 = \text{frames}$

$R_2 = \text{ticks}$

Video group chat primary result for video encoding =  
sink\_average\_time\_per\_frame secondary result

# VIDEO GROUP CHAT IN CREATIVE 2.0 (COMPATIBILITY MODE)

Components stressed by this workload	CPU, GPU or custom hardware depending on the Windows Media Foundation encoders and the OpenCL setup
Benchmarks that use this test	Creative

## Implementation

The workload is based on a group video chat application that displays three incoming video streams and one outgoing, which is encoded in the background.

Media playback and encoding are based on Windows Media Foundation. The incoming stream is, in practice, a local H.264 720p video played back in a window. The outgoing stream features face detection using an open source library called OpenCV that draws a rectangle around the speaker's face.

The source content is a 1 second buffer (30 frames) of raw video to simulate a web cam. The destination of the encoded video is a memory buffer that discards frames to simulate output to a network.

## Scoring

Video group chat primary result for video playback =  $R_1 / R_2$

Where:

$R_1$  = frames

$R_2$  = ticks

Video group chat primary result for video encoding =  
sink\_average\_time\_per\_frame secondary result

# SPREADSHEET

Components stressed by this workload CPU, GPU (with OpenCL)

Benchmarks that use this test Work

## Implementation

The workload is based on processing a large volume of data using a spreadsheet application. The workload uses [LibreOffice Calc](#), a part of the open-source productivity suite from The Document Foundation.

## Tasks

1. Start Calc
2. Open the source and destination workbooks.
3. Stretch the application windows from an initial state
4. Copy data from the source workbook into the destination workbook to cells that trigger formula evaluation. The data is approximately 375,000 cells.
5. Copy data from the source workbook to the destination workbook to cells that do not trigger formula evaluation. The data set is approximately 375,000 cells.
6. Copy formulas from inside the destination workbook so that data evaluation for the data copied in task 5 is triggered. The copied data is 3 cells in size and it is pasted into approximately 75,000 cells.
7. Copy more data from the source workbook to the destination workbook to cells that trigger formula evaluation. The data set is approximately 200 cells.
8. Plug specific values to three individual cells triggering formula evaluation.
9. Save the destination workbook into a new file.

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_2, R_4, R_5, R_6, R_7, R_8, R_9)$$

Where:

- $R_2 = \text{open\_document\_time}$
- $R_4 = \text{copy\_data\_and\_compute\_time}$
- $R_5 = \text{copy\_plain\_data\_time}$
- $R_6 = \text{copy\_formulas\_time}$

$R_7 = \text{copy\_data\_and\_compute\_2\_time}$

$R_8 = \text{edit\_cells\_time}$

$R_9 = \text{save\_document\_time}$

# STORAGE WORKLOADS

Components stressed by this workload      Storage system

Benchmarks that use this test      Storage

## Implementation

The PCMark 8 Storage test simulates disk activity by playing back a trace of storage activity recorded during actual use of applications from the Adobe Creative Suite, Microsoft Office and a selection of popular games.

Traces consist of a list of I/Os with following information:

1. timing, both start and end of I/O
2. starting LBA
3. length of I/O in bytes

The traces support both x86 and x64 platforms.

An important change in the PCMark 8 trace playback engine, compared with PCMark 7, is that idle time compression is removed completely. The change was made to make the benchmark behave more like real-world applications.

## Storage benchmark v2.0

 The Storage benchmark was updated to v2.0 in January 2016 to better support NVMe drives. Enable [Compatibility Mode](#) if you need to compare scores against historical result data from v1.0 of the test. Scores from v2.0 and v1.0 are not comparable.

Version 2.0 of the Storage benchmark includes two changes to the storage playback engine:

1. Write I/Os sent to the storage device no longer have the Force Unit Access flag enabled. This flag did not usually matter to older storage devices but could lead to reduced performance on some modern NVMe drives.
2. The playback engine now aligns all I/Os on 4096 byte boundaries. This change improves test compatibility across modern devices.

Updated workloads are designated with "v2". The traces (described below) are unchanged.

### Storage - Adobe Photoshop light

Storage trace recorded from the Adobe Photoshop light and heavy Applications test.

Bytes read: 313 MB

Bytes written: 2336 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	479	680	349	1508	68.83%
Random reads	8215	9249	61	17525	68.25%
Sequential writes	223	861	17258	18342	99.91%
Random writes	214	246	1283	1743	99.20%

### Storage - Adobe Photoshop heavy

Storage trace recorded from the Adobe Photoshop light and heavy Applications test.

Bytes read: 468 MB

Bytes written: 5640 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	706	3288	283	4277	88.05%
Random reads	8980	9623	52	18655	68.94%
Sequential writes	250	904	43588	44742	100.00%
Random writes	440	208	1417	2065	98.64%

### Storage – Adobe Illustrator

Bytes read: 373 MB

Bytes written: 89 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	274	709	53	1036	65.64%
Random reads	9716	12181	26	21923	63.31%
Sequential writes	5	15	662	682	99.12%
Random writes	373	127	32	532	97.37%

### Storage – Adobe InDesign

Bytes read: 401 MB

Bytes written: 624 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	575	1571	213	2359	37.94%
Random reads	10913	11240	54	22207	65.40%
Sequential writes	4	49	4821	4874	100.00%
Random writes	528	283	116	927	98.71%

### Storage - Adobe After Effects

Storage trace recorded from Adobe After Effects Applications test.

Bytes read: 311 MB

Bytes written: 16 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	278	1415	79	1772	30.76%
Random reads	8144	9637	12	17793	55.11%
Sequential writes	4	18	64	86	82.56%
Random writes	349	102	49	500	77.80%

### Storage – Microsoft Word

Storage trace recorded from Microsoft Word Applications test.

Bytes read: 107 MB

Bytes written: 95 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	36	100	16	152	67.11%
Random reads	741	3560	1	4302	47.77%
Sequential writes	2	15	731	748	99.47%
Random writes	133	51	21	205	96.10%

### Storage – Microsoft Excel

Storage trace recorded from Microsoft Excel Applications test.

Bytes read: 73 MB

Bytes written: 15 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	23	49	0	72	50.00%

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Random reads	539	2609	0	3148	39.74%
Sequential writes	2	2	115	119	98.32%
Random writes	63	14	10	87	97.70%

### Storage – Microsoft PowerPoint

Storage trace recorded from Microsoft PowerPoint Applications test.

Bytes read: 83 MB

Bytes written: 21 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	22	34	0	56	26.79%
Random reads	633	2808	0	3441	40.51%
Sequential writes	2	2	143	147	98.64%
Random writes	68	14	25	107	98.13%

### Storage – World of Warcraft

The storage trace is recorded while the user starts World of Warcraft, logs in and starts playing.

Bytes read: 390 MB

Bytes written: 5 MB

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential reads	264	545	606	1415	93.07%
Random reads	5237	9308	382	14927	71.68%

	up to 4096	up to 64k	up to 128k:	Total:	4k aligned %
Sequential writes	0	7	3	10	100.00%
Random writes	494	161	4	659	96.66%

### Storage - Battlefield 3

The storage trace is recorded while the user starts Battlefield 3, logs in, loads a saved game and starts playing.

Bytes read: 887 MB

Bytes written: 28 MB

	up to 4096	up to 64k	up to 128k	Total	4k aligned %
Sequential reads	1093	2716	1973	5782	90.35%
Random reads	24231	17920	1336	43487	88.79%
Sequential writes	12	39	167	218	97.71%
Random writes	268	135	28	431	92.81%

# CONSISTENCY TEST

PCMark 8 v2.3.293 added the ability to customize the Storage Consistency test. You'll find details and instructions in the [PCMark 8 Storage Consistency Customization Guide](#).

## Precondition phase

1. Write the drive sequentially through up to the reported capacity with random data, write size of  $256 \times 512 = 131,072$  bytes.
2. Write it through a second time (to take care of overprovisioning).

## Degradation phase

1. Run writes of random size between  $8 \times 512$  and  $2048 \times 512$  bytes on random offsets for 10 minutes.
2. Run performance test (one pass only). The result is stored in secondary results with name prefix `degrade_result_X` where X is a counter.
3. Repeat 1 and 2 for 8 times and on each pass increase the duration of random writes by 5 minutes.

## Steady state phase

1. Run writes of random size between  $8 \times 512$  and  $2048 \times 512$  bytes on random offsets for final duration achieved in degradation phase.
2. Run performance test (one pass only). The result is stored in secondary results with name prefix `steady_result_X` where X is a counter.
3. Repeat 1 and 2 for 5 times.

## Recovery phase

1. Idle for 5 minutes.
2. Run performance test (one pass only). The result is stored in secondary result with name `recovery_result_X` where X is a counter.
3. Repeat 1 and 2 for 5 times.

## Clean up

1. Write the drive sequentially through up to the reported capacity with zero data, write size of  $256 \times 512 = 131,072$  bytes.

# ADAPTIVITY TEST

The Adaptivity test has three phases:

## Precondition phase

1. Write the drive sequentially through up to the reported capacity with random data, write size of  $256 \times 512 = 131,072$  bytes.
2. Write it through a second time (to take care of overprovisioning).

## Steady state phase

1. Idle for 5 minutes.
2. Run performance test (one pass only). The result is stored in secondary result with name `steady_result_X` where X is a counter.
3. Repeat 1 and 2 for 10 times.

## Clean up

1. Write the drive sequentially through up to the reported capacity with zero data, write size of  $256 \times 512 = 131,072$  bytes.

# APPLICATION WORKLOADS

# ADOBE PHOTOSHOP LIGHT

Components stressed by this workload CPU, storage

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Benchmarks that use this test Applications

## Implementation

The workload involves editing a series of photographs.

### Tasks

1. Start Photoshop.
2. Open a series of 14 images, one by one. For each, perform a series of operations:
  - 2.1 Close the previous image if one is open.
  - 2.2 Adjust color balance.
  - 2.3 Apply auto levels.
  - 2.4 Adjust shadows and highlights.
  - 2.5 Downscale the image using bicubic interpolation.
  - 2.6 Apply unsharp mask to the image.
  - 2.7 Save the image into a new file.
3. Close the final image and exit Photoshop.

### Summary

	Images	File sizes	Resolution
Source	14	3.9-17.6 MB	2500 × 1677 6048 × 4032
Destination	14	388-778 KB	1200 × 800

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, \dots, R_{24})$$

Where:

- $R_1$  = open\_photoshop\_time secondary result
- $R_2$  = process\_image\_01\_time secondary result
- $R_3$  = process\_image\_02\_time secondary result
- $R_4$  = process\_image\_03\_time secondary result
- $R_5$  = process\_image\_04\_time secondary result
- $R_6$  = process\_image\_05\_time secondary result
- $R_7$  = process\_image\_06\_time secondary result
- $R_8$  = process\_image\_07\_time secondary result
- $R_9$  = process\_image\_08\_time secondary result
- $R_{10}$  = process\_image\_09\_time secondary result
- $R_{11}$  = process\_image\_10\_time secondary result
- $R_{12}$  = process\_image\_11\_time secondary result
- $R_{13}$  = process\_image\_12\_time secondary result
- $R_{14}$  = open\_image\_13\_time secondary result
- $R_{15}$  = adjust\_colors\_of\_image\_13\_time secondary result
- $R_{16}$  = resize\_image\_13\_time secondary result
- $R_{17}$  = apply\_unsharp\_mask\_to\_image\_13\_time secondary result e,
- $R_{18}$  = save\_image\_13\_time secondary result
- $R_{19}$  = open\_image\_14\_time secondary result
- $R_{20}$  = adjust\_colors\_of\_image\_14\_time secondary result
- $R_{21}$  = resize\_image\_14\_time secondary result
- $R_{22}$  = apply\_unsharp\_mask\_to\_image\_14\_time secondary result
- $R_{23}$  = save\_image\_14\_time secondary result
- $R_{24}$  = close\_photoshop\_time secondary result

# ADOBE PHOTOSHOP HEAVY

Components stressed by this workload CPU, storage

Benchmarks that use this test Applications

## Implementation

The workload is based on editing a high-resolution photo to create a poster.

### Tasks

1. Start Photoshop.
2. Open a PSD document.
3. Upscale the image using bicubic interpolation.
4. Change the color depth to 16 bits per channel.
5. Create a color range selection and paste it into a new layer.
6. Merge the two existing image layers and place the new layer topmost.
7. Apply lens blur to the topmost layer.
8. Select an elliptical area in the topmost layer and remove it.
9. Merge all existing layers into a new topmost layer.
10. Apply Gaussian blur to the topmost layer.
11. Select a gradient mask and remove the selection from the topmost layer.
12. Reduce the opacity of the topmost layer.
13. Save the image into a new PSD file.
14. Export the image into a new TIFF file.
15. Flatten the image and downscale it using bicubic interpolation.
16. Apply unsharp mask on the image.
17. Export the image into a new JPEG file.
18. Close the image and exit Photoshop.

### Summary

	File size	Resolution	DPI	Layers
Source PSD	113 MB	5184 × 7744	300 DPI	1
Final PSD	1320 MB	7000 × 10457	300 DPI	4
Final TIFF	476 MB	7000 × 10457	300 DPI	n/a

	File size	Resolution	DPI	Layers
Final JPEG	177 KB	1000 × 1494	300 DPI	n/a

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, \dots, R_{18})$$

Where:

- $R_1$  = open\_photoshop\_time secondary result
- $R_2$  = open\_document\_time secondary result
- $R_3$  = resize\_image\_time secondary result
- $R_4$  = edit\_color\_mode\_time secondary result
- $R_5$  = create\_color\_range\_layer\_time secondary result
- $R_6$  = merge\_layers\_time secondary result
- $R_7$  = apply\_lens\_blur\_time secondary result
- $R_8$  = edit\_lens\_blur\_layer\_time secondary result
- $R_9$  = remerge\_layers\_time secondary result
- $R_{10}$  = apply\_gaussian\_blur\_time secondary result
- $R_{11}$  = clear\_gradient\_time secondary result
- $R_{12}$  = set\_top\_layer\_opacity\_time secondary result
- $R_{13}$  = save\_document\_time secondary result
- $R_{14}$  = export\_to\_tiff\_time secondary result
- $R_{15}$  = flatten\_and\_resize\_image\_time secondary result
- $R_{16}$  = apply\_unsharp\_mask\_time secondary result
- $R_{17}$  = export\_to\_jpeg\_time secondary result
- $R_{18}$  = close\_photoshop\_time secondary result

# ADOBE INDESIGN

Components stressed by this workload CPU, storage

Benchmarks that use this test Applications

## Implementation

The workload involves preparing a publication with a large number of images.

### Tasks

1. Start InDesign.
2. Open an InDesign document.
3. Resize and reposition images. Add a colored rectangle for decoration.
4. Change the document's margin settings.
5. Add text into the document.
6. Save the document into a new file.
7. Export the document into a new PDF file.
8. Close the document and exit InDesign.

### Summary

	File size	Pages	Images
Initial file	385 MB	40	42
Final file	378 MB	40	40
Final PDF	64.7 MB	40	40

## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8)$$

Where:

- $R_1$  = open\_indesign\_time secondary result
- $R_2$  = open\_document\_time secondary result
- $R_3$  = place\_images\_time secondary result
- $R_4$  = adjust\_margins\_time secondary result
- $R_5$  = add\_text\_time secondary result
- $R_6$  = save\_documents\_time secondary result
- $R_7$  = export\_to\_pdf\_time secondary result

$R_8 = \text{close\_indesign\_time}$  secondary result

# ADOBE ILLUSTRATOR

Components stressed by this workload CPU, storage

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Benchmarks that use this test Applications

## Implementation

The workload involves preparing a presentation based on images created using Photoshop.

### Tasks

1. Start Illustrator.
2. Open an Illustrator document.
3. Resize and reposition images. Add a translucent filled rectangle for color effect.
4. Vectorize the images in the document.
5. Add text labels, lines, rectangles, ellipses, stars and a curved path into the document.
6. Save the document into a new file.
7. Export the document into a PDF file.
8. Close the document and exit Illustrator.

### Summary

	File size
Initial file	733 KB
Final file	6.2 MB
Final PDF	5.6 MB

### Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8)$$

Where:

- $R_1$  = open\_illustrator\_time secondary result
- $R_2$  = open\_document\_time secondary result
- $R_3$  = resize\_and\_move\_time secondary result
- $R_4$  = vectorize\_time secondary result
- $R_5$  = add\_items\_time secondary result

$R_6$  = save\_time secondary result  
 $R_7$  = export\_time secondary result  
 $R_8$  = close\_illustrator\_time secondary result

# ADOBE AFTER EFFECTS IN ADOBE CREATIVE CLOUD TEST V2.0

Components stressed by this workload CPU, storage

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Benchmarks that use this test Applications

## Implementation

The user runs After Effects to render a video that has been prepared earlier. The user wants the rendering to complete as quickly as possible.

### Tasks

The prepared video is passed to AERender for processing at 1920 × 1080 (1080p) at 30 fps.

The settings used are:

- Uncompressed AVI

### Summary

	File size	Resolution	Data rate	Audio	Total bitrate
Final file	890 MB	1080p, 30 fps	1458 Mbps	1536 kbps @ 48 kHz stereo	1459 Mbps

## Scoring

The primary result is the time spent on rendering.

# ADOBE AFTER EFFECTS IN ADOBE CREATIVE SUITE TEST V1.0 (COMPATIBILITY MODE)

Components stressed by this workload CPU, storage

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Benchmarks that use this test Applications

## Implementation

The user runs After Effects to render a video that has been prepared earlier. The user wants the rendering to complete as quickly as possible.

### Tasks

The prepared video is passed to AERender for processing at 1920 × 1080 at 30 frames per second.

The settings used are:

- Windows Media Video 9 advanced profile
- Constant bitrate 0.9 Mbps
- Image quality 98
- Keyframe interval 1 second
- Buffer size 1 seconds
- Constant bitrate audio 256 kbps, 44 kHz, stereo (A/V) CBR
- Windows Media Audio 9.2

### Summary

	File size	Resolution	Data rate	Audio	Total bitrate
Final file	5.64 MB	1080p, 30 fps	0.9 Mbps	256 kbps @ 44 kHz stereo	0.9256 Mbps

### Scoring

The primary result is the time spent on rendering.

# MICROSOFT WORD

Components stressed by this workload CPU, storage

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Benchmarks that use this test Applications

## Implementation

The workload involves making a series of edits to a long research paper.

### Tasks

1. Start Word.
2. Open the source document.
3. Open the destination document into a separate window.
4. Copy a long segment from the source document to the destination document.
5. Save the destination document with a new file name.
6. Stretch the destination document window.
7. Cut and paste a long segment within the destination document.
8. Save the destination document.
9. Type text into the document, simulating keystrokes by sleeping after each character.
10. Save the destination document.
11. Add images into the destination document.
12. Save the destination document.

### Summary

	File size	Pages	Word count	Images
Initial document	3.25 MB	77	17,987	5
Final document	57 MB	138	30,800	10

### Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10}, R_{11})$$

Where:

$R_1$  = source\_document\_display\_time secondary result

$R_2$  = destination\_document\_display\_time secondary result

$R_3$  = copy\_and\_paste\_time secondary result  
 $R_4$  = save\_target\_document\_1\_time secondary result  
 $R_5$  = resize\_target\_document\_window\_time secondary result  
 $R_6$  = cut\_and\_paste\_time secondary result  
 $R_7$  = save\_target\_document\_2\_time secondary result  
 $R_8$  = type\_text\_to\_destination\_document\_time secondary result  
 $R_9$  = save\_target\_document\_3\_time secondary result  
 $R_{10}$  = add\_pictures\_to\_destination\_document secondary result  
 $R_{11}$  = save\_target\_document\_4\_time secondary result

# MICROSOFT EXCEL

Components stressed by this workload CPU, storage

Benchmarks that use this test Applications

## Implementation

The workload involves making a series of changes and additions to a large Excel workbook.

### Tasks

1. Start Excel.
2. Open the source and destination workbooks.
3. Stretch the application window.
4. Copy data from the source workbook into the destination workbook to cells that trigger formula evaluation. The data set is approximately 75,000 cells.
5. Copy more data from the source workbook to the destination workbook to cells that do not trigger formula evaluation. The data set is approximately 75,000 cells.
6. Copy formulas from inside the destination workbook so that data evaluation for the data copied in task 5 is triggered. The copied data is 3 cells in size and it is pasted into approximately 15,000 cells.
7. Copy more data from the source workbook to the destination workbook to cells that trigger formula evaluation. The data set is approximately 20 cells.
8. Plug specific values to three individual cells triggering formula evaluation.
9. Save the destination workbook into a new file.

### Summary

	File size	Worksheets	Active cells
Initial files	4.62 MB	4	240,800 approx.
	2.33 MB		
Final file	4.18 MB	2	10,930 approx.



## Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10}, R_{11})$$

Where:

$R_1$  = start\_application\_time secondary result

$R_2$  = open\_document\_time secondary result

$R_3$  = resize\_window\_time secondary result

$R_4$  = copy\_data\_and\_compute\_time secondary result

$R_5$  = copy\_plain\_data\_time secondary result

$R_6$  = copy\_formulas\_time secondary result

$R_7$  = copy\_data\_and\_compute\_2\_time secondary result

$R_8$  = edit\_cells\_time secondary result

$R_9$  = save\_document\_time secondary result

# MICROSOFT POWERPOINT

Components stressed by this workload CPU, storage

Benchmarks that use this test Applications

## Implementation

The workload involves making a series of edits to an image-rich PowerPoint presentation.

### Tasks

1. Start PowerPoint.
2. Open the presentation.
3. Stretch the application window.
4. Browse through each slide in turn and simulate reviewing by sleeping each slide.
5. Add a slide to the presentation.
6. Add an image to the new slide and crop it.
7. Add text to the new slide.
8. Save the finished presentation into a new file.
9. Export the presentation into a PDF file.

### Summary

	File size	Slides	Images
Initial files	27.1 MB	15	12
Final PDF	2.83 MB	16	13

### Scoring

$$\text{Primary result} = \text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5, R_6)$$

Where:

- $R_1$  = start\_application\_time secondary result
- $R_2$  = open\_document\_time secondary result
- $R_3$  = browse\_document\_time secondary result
- $R_4$  = add\_and\_adjust\_image\_time secondary result
- $R_5$  = add\_text\_time secondary result
- $R_6$  = export\_to\_pdf\_time secondary result

# BENCHMARK SCORES

# HOW TO REPORT SCORES FROM PCMARK 8

Please follow these guidelines when including PCMark 8 scores in reviews or marketing materials to avoid confusing your customers and to ensure you represent our software correctly.

Each test gives its own score, which you can use to compare similar devices or systems. There is no overall 3DMark score. Scores from different tests are not comparable. Do not use PCMark as a unit of measurement.

- ✓ "Tablet scores 2,000 in PCMark 8 Creative Accelerated benchmark."
- × "Tablet scores 2,000 PCMarks."

Always include details of the hardware setup you used to obtain the score. Be sure to include the operating system, system hardware and version numbers for relevant drivers.

## Using PCMark scores in marketing material

You must have a commercial license to use PCMark 8 scores in marketing material. A commercial license is granted with the purchase of PCMark 8 Professional Edition or through our site licensing program.

On the first mention of PCMark 8 in marketing text, such as an advertisement or product brochure, please write "PCMark 8 benchmark" in order to protect our trademark. For example:

"We recommend the PCMark® 8 benchmark from UL®."

Please include our legal text in your small print.

PCMark® is a registered trademark of Futuremark Corporation.

## SCORING

Each test run reports a score. Scores from different tests are not comparable. For instance, you should not compare Home scores directly with Creative scores.

### Home 3.0, Home 2.0 (Compatibility Mode)

$$PCMark 8 \text{ Home score} = \frac{K}{\text{GEOMEAN}(R_1, R_2, R_3, R_4, \text{GEOMEAN}\left(\frac{1}{R_5}, R_6\right), \frac{1}{R_7})}$$

Where:

- $R_1$  = Web Browsing - JunglePin primary result
- $R_2$  = Web Browsing - Amazonia primary result
- $R_3$  = Writing primary result
- $R_4$  = Photo Editing primary result
- $R_5$  = Video Chat playback 1 primary result
- $R_6$  = Video Chat encoding primary result
- $R_7$  = Casual Gaming primary result

And depending on the test version:

K = 2100 for Home 2.0

K = 1200 for Home 3.0

## Creative 3.0, Creative 2.0 (Compatibility Mode)

PCMark 8 Creative score

$$= \frac{K}{\text{GEOMEAN}(R_1, R_2, \text{GEOMEAN}(\text{GEOMEAN}(\frac{1}{R_3}, \frac{1}{R_4}, \frac{1}{R_5}), R_6), R_7, R_8, \text{GEOMEAN}(R_9, R_{10}), \text{GEOMEAN}(R_{11}, R_{12}), \text{GEOMEAN}(R_{13}, R_{14}), \text{GEOMEAN}(R_{15}))}$$

Where:

- $R_1$  = **Web Browsing** - JunglePin primary result
- $R_2$  = **Web Browsing** - Amazonia primary result
- $R_3$  = Video Group Chat playback 1 primary result
- $R_4$  = Video Group Chat playback 2 primary result
- $R_5$  = Video Group Chat playback 3 primary result
- $R_6$  = Video Group Chat encoding primary result
- $R_7$  = Photo Editing primary result
- $R_8$  = Batch Photo Editing primary result
- $R_9$  = Video Editing 1 primary result
- $R_{10}$  = Video Editing 2 primary result
- $R_{11}$  = Video To Go 1080p primary result
- $R_{12}$  = Video To Go 720p primary result
- $R_{13}$  = Audio To Go primary result
- $R_{14}$  = Mainstream Gaming 1 primary result
- $R_{15}$  = Mainstream Gaming 2 primary result

And depending on the test version:

K = 6800 for Creative 2.0

K = 5200 for Creative 3.0

## Work 2.0

$$PCMark 8 Work score = \frac{4200}{GEOMEAN(R_1, R_2, R_3, R_4, GEOMEAN(\frac{1}{R_5}, R_6))}$$

Where:

- $R_1$  = Web Browsing - JunglePin primary result
- $R_2$  = Web Browsing - Amazonia primary result
- $R_3$  = Writing primary result
- $R_4$  = Spreadsheet primary result
- $R_5$  = Video Chat playback 1 primary result
- $R_6$  = Video Chat encoding primary result

## Work 1.0 (Compatibility Mode)

$$PCMark 8 Work score = \frac{2600}{GEOMEAN(R_1, R_2, R_3)}$$

Where:

- $R_1$  = Web Browsing - JunglePin primary result
- $R_2$  = Web Browsing - Amazonia primary result
- $R_3$  = Writing primary result

## Storage

The primary result of each storage test is the total time elapsed while playing back the trace. The primary result is used to calculate Storage score.

$$PCMark\ 8\ Storage\ score = \frac{270000}{GEOMEAN(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10})}$$

Where:

- $R_1$  = Storage: World of Warcraft primary result
- $R_2$  = Storage: Battlefield 3 primary result
- $R_3$  = Storage: Adobe Photoshop light primary result
- $R_4$  = Storage: Adobe Photoshop heavy primary result
- $R_5$  = Storage: Adobe InDesign primary result
- $R_6$  = Storage: Adobe After Effects primary result
- $R_7$  = Storage: Adobe Illustrator primary result
- $R_8$  = Storage: Microsoft Word primary result
- $R_9$  = Storage: Microsoft Excel primary result
- $R_{10}$  = Storage: Microsoft PowerPoint primary result

The secondary result of the test is bandwidth, which is the total amount of bytes read and written during the test divided by busy time (in other words, the time when the depth of the queue of pending I/O operations was at least 1). The bandwidth result is used to calculate Storage bandwidth, which is reported along with Storage score.

$$PCMark\ 8\ Storage\ bandwidth,\ in\ MB/s = GEOMEAN(S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10})$$

Where:

- $S_1$  = Storage: World of Warcraft bandwidth result
- $S_2$  = Storage: Battlefield 3 bandwidth result
- $S_3$  = Storage: Adobe Photoshop light bandwidth result
- $S_4$  = Storage: Adobe Photoshop heavy bandwidth result
- $S_5$  = Storage: Adobe InDesign bandwidth result
- $S_6$  = Storage: Adobe After Effects bandwidth result
- $S_7$  = Storage: Adobe Illustrator bandwidth result
- $S_8$  = Storage: Microsoft Word bandwidth result
- $S_9$  = Storage: Microsoft Excel bandwidth result
- $S_{10}$  = Storage: Microsoft PowerPoint bandwidth result

## Expanded Storage

The purpose of the Expanded Storage test is to go deeper than the Storage test. This deep performance analysis requires more than a single number. As such, interpreting the results of the Expanded Storage tests is not trivial.

In future releases we plan to improve the presentation of the results. Until then understanding the data from this benchmark requires some effort and understanding of storage concepts.

The results of the test can be seen in the result XML file. A way to access the XML is to open the result file from PCMark 8's GUI and click "View raw result" button.

- For the Consistency test, the primary result is the worst performance score encountered during the benchmark run.
- For the Adaptivity test, the primary result is the best performance score encountered during the benchmark run.

Both primary results are massive simplifications so it's better to dig deeper into the results. There are a lot of secondary results. They are grouped with prefixes that match to a certain test phase:

- degrade\_X
- steady\_X
- recovery\_X

The details of each iteration of the test are available in each phase, which enables you to track performance in each subtest.

You could also concentrate on secondary results of form (degrade/steady/recovery)\_X\_score and (degrade/steady/recovery)\_X\_bandwidth which can be used to plot a curve that illustrates changes in performance during the test, for example.

PCMark 8 v2.3.293 added the ability to customize the Storage Consistency test. You'll find details and instructions in the [PCMark 8 Storage Consistency Customization Guide](#).

## Applications

$$\begin{aligned} \text{PCMark 8 Adobe Creative Suite Applications score} \\ &= \frac{17000}{\text{GEOMEAN}(R_1, R_2, R_3, R_4, R_5)} \end{aligned}$$

Where:

- $R_1$  = Adobe Photoshop light primary result
- $R_2$  = Adobe Photoshop heavy primary result
- $R_3$  = Adobe InDesign light primary result
- $R_4$  = Adobe After Effects primary result
- $R_5$  = Adobe Illustrator primary result

$$\text{PCMark 8 Microsoft Office Applications score} = \frac{4800}{\text{GEOMEAN}(R_1, R_2, R_3)}$$

Where:

- $R_1$  = Microsoft Word primary result
- $R_2$  = Microsoft Excel primary result
- $R_3$  = Microsoft PowerPoint primary result

## Battery Life

The reported battery life is an estimate for a 95% duty cycle (from 100% charged to 5%) extrapolated from the actual, measured battery life during the benchmark run:

$$\text{BatteryLife} = 0.95 * \frac{\text{RunTime}}{\text{BatteryLevelOnStart} - \text{BatteryLevelOnEnd}}$$

# RELEASE NOTES

## PCMark 8 v2.10.901 – May 31, 2018

### Improved

- Systeminfo updated to version 5.10 for improved compatibility with the latest hardware.

### Fixed

- Improved OpenCL driver detection.
- Results now show the correct OpenCL device used for the Photo Editing test.

## PCMark 8 v2.9.811 – May 4, 2018

This is a minor update. Benchmark scores are not affected.

### Improved

- Systeminfo updated to version 5.9 for improved hardware compatibility.

### Fixed

- The Result screen now shows the correct stock clock speed for AMD Ryzen processors.

### Professional Edition

- PDF Export now works correctly with SystemInfo version 5.6 and above for non-English locales.
- PDF Export now shows the correct stock clock speed for AMD Ryzen processors.

## PCMark 8 v2.8.704 – December 13, 2017

This is a minor update. Benchmark scores are not affected.

### Improved

- Systeminfo updated to version 5.3 for improved hardware compatibility.

### Fixed

- To avoid the Video Editing test running out of memory, it is now limited to 16 threads on processors with high-core counts. This does not affect the score.

## **PCMark 8 v2.7.613 – April 13, 2016**

This is a minor update. Benchmark scores are not affected.

### **Improved**

- SystemInfo module updated to 4.45 for improved hardware compatibility.

### **Fixed**

- Fixed an issue where the Photo Editing tests failed to run when the system path name included non-Latin characters.

### **Professional Edition only**

- Improved reporting of system information in the PDF report adds detailed OS version, detailed storage information, write cache policy information, power profile information, and the number of memory channels. The application version number is shown in the header. The drive used in storage test is shown next to the scores.

## **PCMark 8 v2.6.517 – February 9, 2016**

This is a minor update. Benchmark scores are not affected.

### **Fixed**

- Fixed an issue with Video Editing tests timing out and leaving entry level CPUs unable to finish the Creative conventional benchmark.

### **Professional Edition only**

- Fixed Expanded Storage test command line options.
- Command line --submit switch no longer opens a web browser window when submitting result data.

## **PCMark 8 v2.6.512 – January 18, 2016**

This major update accommodates a change in the latest version of Adobe After Effects and provides better support for NVMe SSDs. These changes affect the workloads in the Adobe Applications benchmark and the Storage benchmark. Scores from the new versions of these tests should not be compared with older versions. Home, Creative, and Work benchmark scores are not affected.

### **Adobe Applications benchmark**

- Adobe Applications benchmark has been updated to version 2.0. Scores should not be compared with earlier versions.

- The After Effects test output has been changed to uncompressed AVI format as the Adobe Creative Cloud version no longer supports output to compressed Windows Media Video format.
- Use Compatibility mode to compare scores with historical result data, (also requires an older version of Adobe software that supports Windows Media Video).

### **Storage benchmark**

- The Storage and Expanded Storage benchmarks have been updated to version 2.0. Scores should not be compared with earlier versions.
- The tests now provide better support for NVMe drives. Scores from NVMe drives will improve in some cases. The faster the drive, the bigger the difference. Other types of drive are unaffected.

### **Improved**

- General stability and error handling has been improved.
- SystemInfo module updated to 4.41 for improved hardware compatibility.

### **Fixed**

- Video Chat test now works even when there is no audio device in the system.
- Fixed a bug that could cause PCMark 8 to crash when the SystemInfo module failed.
- Fixed several issues found on non-English language Windows installations.

### **Professional Edition only**

- Command line now offers temp path selection.
- XML output now shows battery life in minutes not seconds for more intuitive results.

## **PCMark 8 v2.5.419 - September 8, 2015**

This is a minor update. Benchmark scores are not affected.

### **Improved**

- Results screen now shows benchmark duration and battery consumption in Benchmark Information section.
- More detailed logging for the Storage test.
- SystemInfo module updated to 4.40 for improved hardware compatibility.

### Fixed

- When loading a result from a previous version of PCMark 8, the Results screen now correctly shows the application version used rather than the current version.
- Fixed a result creation issue that occurred when SystemInfo was disabled.

### Professional Edition only

- New Command Line exit codes to assist with scripting.
- Fixed an issue when trying to use the --out and --export-pdf Command Line options at the same time.
- PDF export of Battery Life results now shows battery life as the overall result and the average score from all benchmark passes as a secondary result.
- PDF export now shows Battery Life in hours and minutes (seconds rounded down).

## PCMark 8 v2.4.304 - April 1, 2015

This is a minor update. Benchmark scores are not affected.

### Improved

- SystemInfo module updated to 4.36 for improved hardware compatibility.

### Fixed

- Spreadsheet test: fixed an issue with test hanging, crashing or not finishing with some hardware platforms in Accelerated mode.

### Compatibility

- Updated LibreOffice to the version in the LibreOffice code repository tagged *libreoffice-4-2-milestone-7-2* for improved compatibility with Intel hardware.

## PCMark 8 v2.3.293 - November 27, 2014

A bug fix in this update means that scores from the Storage Consistency and Storage Adaptivity tests included in PCMark 8 Professional Edition may improve slightly on some hardware. Other benchmark scores are not affected.

### Improved

- SystemInfo module updated to 4.31 for improved hardware compatibility.

## Fixed

- Fixed an issue that could cause the Adobe After Effects test to fail.
- Fixed an issue that prevented the Storage benchmark from running on dynamic disks, including stripes and mirrors.

## Professional Edition only

- PDF report now includes details of the screen resolution and memory modules.
- Fixed a data alignment issue in the Storage Consistency test that could result in read-modify-write operations when a simple write was intended. Scores from this test may improve on devices previously affected by the bug.
- Added --custom command line option to enable the Storage Consistency test to be customized for selected use cases. See the [PCMark 8 Storage Consistency Customization Guide](#) for details.

## PCMark 8 v2.2.282 – October 2, 2014

This is a minor update. Benchmark scores are not affected.

## Improved

- SystemInfo module updated to 4.30 for improved hardware compatibility with X99 platforms.

## Fixed

- Fixed Adobe Creative Cloud 2014 compatibility issue which prevented After Effects test from running.

## Professional Edition only

- The command line application now checks software requirements only when needed. This enables you to run benchmarks on systems that do not meet all the requirements, for example, running the Storage benchmark on a virtualized system without DirectX 11 support.
- New command line --pass option can be used to set the number of benchmark passes. See command line guide for details.

## PCMark 8 v2.1.274 – June 30, 2014

This is a minor update. Benchmark scores are not affected.

## Professional Edition only

- Professional Edition users can now export results as PDF files from the Results screen, saved result files and the command line.

### **Improved**

- SystemInfo module updated to 4.29 for improved hardware detection.

### **Fixed**

- Fixed a bug that left the PCMark.exe process running after closing the application.

## **PCMark 8 v2.0.228 - March 12, 2014**

This is a minor update. Benchmark scores are not affected.

### **Improved**

- SystemInfo module updated to 4.26 for improved hardware detection.

### **Fixed**

- Photo Editing test: fixed the issue with error message, "Init error: System.BadImageFormatException."
- Video Editing test: fixed the issue with error message, "file is too small."

### **Steam version only**

- Fixed an issue that gave an error when choosing to view results online.

### **Professional Edition only**

- Added command line option --randomdata to Expanded Storage Test. See command line guide for details.

## **PCMark 8 v2.0.204 – February 4, 2014**

This is a minor update. Benchmark scores are not affected.

### **Fixed**

- Fixed an issue that prevented PCMark 8 from launching after a recent Steam update.
- Fixed an issue with Expanded Storage tests (Professional Edition only) that could result in the unintentional removal of the partition table from a non-empty drive.

## **PCMark 8 v2.0.191 – January 17, 2014**

This is a major update for the Professional Edition that adds new tests and workloads. Home, Creative and Work scores from PCMark 8 v2.0.X cannot be compared with previous versions, however, this update adds a new Compatibility Mode that enables you to run older versions of each test for when you need to compare scores with historical benchmark results.

### **Home benchmark**

- Home updated to version 3.0. Scores should not be compared with version 2.0.
- New Photo Editing test using the open source ImageMagick library and a wider variety of image processing operations.
- Video Chat test now features improved face detection and performance. The test has been updated to use OpenCV 2.4.7.

### **Creative benchmark**

- Creative updated to version 3.0. Scores should not be compared with version 2.0.
- New Photo Editing test using the open source ImageMagick library and a wider variety of image processing operations.
- Video Editing part 2 now uses source material in 4K UHD resolution (3840 × 2160).
- Video Group Chat test now features improved face detection and performance. The test has been updated to use OpenCV 2.4.7.

### **Work benchmark**

- Work updated to version 2.0. Scores should not be compared with version 1.0.
- Work v2.0 adds a new Spreadsheet test and includes the Video Chat test to provide a more varied and representative benchmark for office productivity use.
- New Spreadsheet test using LibreOffice Calc, a part of the open-source productivity suite from The Document Foundation.
- Added Video Chat test to the benchmark.

### **Storage benchmark**

- Storage updated to version 1.1. Scores are comparable with version 1.0.
- Added Expanded Storage tests for specialist analysis of drive performance. Please note that these tests can only be run from the command line using PCMark 8 Professional Edition.

### **Compatibility Mode**

- Compatibility Mode enables you to run the Home, Creative and Work benchmarks from version 1.2.157 for times when you need to compare scores against historical result data.

## **PCMark 8 v2.0.162 – December 31, 2013**

PCMark 8 version 2.0.162 was a special preview build of PCMark 8 v2.0.191 Professional Edition made available to selected members of the press.

## **PCMark 8 v1.2.157 – October 21, 2013**

### **New**

- Basic and Advanced Editions now available.
- You can now submit and save scores online.

### **Improved**

- Various UI improvements.

## **PCMark 8 v1.1.111 – October 10, 2013**

This is an update for the Professional Edition. Scores from Work, Storage and Applications are not affected by this update. Scores from Home and Creative should not be compared with scores from previous versions due to the addition of new run modes for those tests.

### **New**

- Home updated to version 2.0. Scores should not be compared with previous versions.
- Creative updated to version 2.0. Scores should not be compared with previous versions.
- Home and Creative benchmarks now offer a choice of run modes.
  - Conventional mode does not use OpenCL acceleration, reflecting how the majority of software works today.
  - Accelerated mode uses OpenCL acceleration, anticipating how software may work in the future.
- New interactive graphs show hardware monitoring data from each benchmark run.

### **Improved**

- Progress windows now show estimated time for each test.
- SystemInfo scan is now at least 50% faster.

### **Compatibility**

- Compatible with Windows 8.1.
- Compatible with Internet Explorer 11.
- SystemInfo updated to v4.21 for improved compatibility with the latest hardware.
- New troubleshooting options for OpenCL device selection in Help tab.

### **Fixed**

- Fixed an issue in the Web Browsing test that could cause the test to hang.

- Fixed an issue with Video Chat and Video Group Chat showing empty windows.
- Fixed a bug that could cause Video Chat tests to return inaccurate results.
- Fixed a crash on 32 bit versions of Windows.

### **PCMark 8 v1.0.0 – May 31, 2013**

- Launch version, Professional Edition only

# ABOUT UL

UL is an independent, global company that offers a wide range of testing, inspection, auditing, and certification services. With 10,000 people in 40 countries, UL helps customers, purchasers, and policymakers navigate market risk and complexity. UL builds trust in the safety, security, and sustainability of products, organizations and supply chains – enabling smarter choices and better lives. Visit <https://www.ul.com/> to find out more.

UL benchmarking software is developed by the Product Supply Chain Intelligence division. We enable global product compliance, innovation and promotion throughout the supply chain with our intelligent software and services backed by world-class scientific and technical expertise. Please visit <https://psi.ul.com/> to find out more.

UL benchmarks help people measure, understand and manage computer hardware performance. Our talented team creates the industry's most trusted and widely used performance tests for desktop computers, notebooks, tablets, smartphones, and VR systems.

We work in cooperation with leading technology companies to develop industry-standard benchmarks that are relevant, accurate, and impartial. As a result, our benchmarks are widely used by the press. UL maintains the world's largest and most comprehensive hardware performance database, using the results submitted by millions of users to drive innovative online solutions designed to help people make informed purchasing decisions.

Our benchmarks are developed in Finland just outside the capital Helsinki. We also have a performance lab and sales office in Silicon Valley and sales representatives in Taiwan.

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