This guide updated April 11, 2018

PCMark 10 – An Industry Standard Benchmark for the Modern Office

PCMark 10 is the latest in our series of industry standard PC benchmarks. Updated for Windows 10 with new and improved workloads, PCMark 10 is also faster and easier to use.

PCMark benchmarks measure complete system performance using tests based on real-world apps and activities. In PCMark 10, these tests reflect common tasks performed in the modern workplace. This makes PCMark 10 the ideal, vendor-neutral benchmark for governments and enterprise organizations that purchase PCs in high-volumes.

PCMark 10 is easy to install and run, with no complicated configuration required. Run the main benchmark and you'll get a PCMark 10 score that you can use to compare systems. There are Extended, Express, and Custom run options for exploring other aspects of performance if needed.

Scores are not comparable across tests, nor are scores from PCMark 10 comparable with the results from other versions of PCMark.

Report your results using the full name of the test, for example:

- ✓ "Notebook scores 5,800 in PCMark 10 benchmark."
- ✗ "Notebook scores 5,800 in PCMark benchmark."

PCMark benchmarks are used by hundreds of hardware review sites and many of the world's leading manufacturers. We hope PCMark 10 will prove to be a valuable tool for you as well.

What's new in this version?

PCMark 10 is the latest version in our series of industry standard PC benchmarking tools. Updated for Windows 10 with new and improved workloads, PCMark 10 is also faster and easier to use than PCMark 8.

Easy to use

PCMark 10 is easy to install and run, with no complicated configuration required. Run the main benchmark and you'll get a PCMark 10 score that you can use to compare systems. PCMark 10 measures overall system performance for modern office work using tests based on real-world apps and activities. There are Extended, Express, and Custom run options for exploring other aspects of performance if needed.

New workloads

PCMark 10 workloads reflect the performance requirements of a range of modern office applications and activities. PCMark 10 updates and improves many of the workloads in PCMark 8 and adds new ones too.

Fast and efficient

With its new and improved workloads, the main PCMark 10 benchmark takes less than half the time of the equivalent test in PCMark 8.

Just click run

In PCMark 10, you no longer have to choose between the Accelerated and Conventional benchmarking modes used in PCMark 8.

Multi-level reporting

Each benchmark run produces a high-level benchmark score, mid-level test group scores, and low-level workload scores. What's more, you can now compare two results side by side in the app.

New yet familiar

PCMark 10 shares the same style of user interface as 3DMark and VRMark. With its familiar layout, it is easy to start benchmarking with PCMark 10.

How does PCMark 10 compare with PCMark 8?

Benchmark comparison

The first release of PCMark 10 focuses on benchmarking system performance with the PCMark 10, PCMark 10 Express and PCMark 10 Extended benchmarks.

Further benchmark tests are in development and will be released as updates. These tests include a dedicated Storage benchmark that improves on the PCMark 8 test, an updated and improved Applications benchmark, and a new Battery Life test.

Running time comparison

PCMark 10 takes less time than PCMark 8. In fact, the main PCMark 10 benchmark takes less than half the time of the equivalent test in PCMark 8.[1]

PCMark 8 Creative	PCMark 10
Conventional: 56 minutes Accelerated: 56 minutes	26 minutes

PCMark 8 Work	PCMark 10 Express
Conventional: 34 minutes Accelerated: 30 minutes	18 minutes

PCMark 8 Home	PCMark 10 Extended
Conventional: 34 minutes Accelerated: 30 minutes	30 minutes

Workload comparison

PCMark 10 workloads reflect the performance requirements of a range of modern office applications and activities. PCMark 10 updates and improves many of the workloads in PCMark 8 and adds new ones too.

---

[1] Average running times based on running each benchmark on 20 different desktop and notebook PC configurations.

PCMark 8	PCMark 10	Improvements in PCMark 10
-	App Start-up	App Start-up is a new workload that measures the time taken to open applications. As well as being key factor in user experience, App Start-up time is a good test of storage performance.
Web Browsing	Web Browsing	The Web Browsing test in PCMark 10 includes a wider variety of scenarios including an online store, social media, maps, online video, and WebGL. The test uses Chromium and Firefox.
Video Chat + Video Group Chat	Video Conferencing	The Video Conferencing test in PCMark 10 raises the resolution from 1280 × 720 to 1920 × 1080. This provides a heavier load that scales better with modern hardware.
Writing	Writing	PCMark 10 improves the Writing workload by using LibreOffice Writer instead of the simpler Workpad-like app used in PCMark 8.
Spreadsheet	Spreadsheets	The Spreadsheets workload in PCMark 10 includes a larger variety of test scenarios with more relevance. The workload has better scaling on high performance CPUs and GPUs.
Photo Editing + Batch Photo Editing	Photo Editing	PCMark 10 uses more photo-processing filters.
Video Editing	Video Editing	The PCMark 10 Video Editing test combines the PCMark 8 Video Editing test and the Video To Go part of the PCMark 8 Media To Go workload.
Media To Go	-	The video parts of the PCMark 8 workload are used in the PCMark 10 Video Editing test. The Music To Go test was dropped from PCMark 10 since audio transcoding is less relevant in 2017.
-	Rendering and Visualization	Rendering and Visualization is a new workload that uses OpenGL to simulate professional graphics and engineering applications. The test provides a relevant use case that scales well with CPU and GPU performance.
Causal Gaming	-	This test was dropped from PCMark 10 since DirectX 9 is less relevant in in today's games.

PCMark 8	PCMark 10	Improvements in PCMark 10
Mainstream Gaming	Gaming	The Gaming test in PCMark 10 has been updated to use a version of the Fire Strike from 3DMark to better represent a modern gaming scenario. The Combined test introduces an additional workload that puts a heavy load on both the CPU and GPU.

PCMark 10 Editions

	Basic Edition	Advanced Edition	Professional Edition
PCMark 10 benchmark	●	●	●
PCMark 10 Express	✕	●	●
PCMark 10 Extended	✕	●	●
Compare results in-app	✕	●	●
Hardware monitoring	✕	●	●
Custom run settings	✕	●	●
Save results offline	✕	●	●
Private, offline results option	✕	✕	●
Command line automation	✕	✕	●
Licensed for commercial use	✕	✕	●
Support	Online	Online	Email & phone

Better benchmarking guide

Using PCMark 10 to specify PC performance

IT managers and procurement specialists can make their IT budget go further by using vendor-neutral benchmarks, like PCMark 10, to specify PC performance in tenders and RFQs.

What is a benchmark?

Writing vendor-neutral tenders for IT systems is not easy. Precisely defining the required system performance is a major challenge to purchasers.

The best approach for describing and comparing the performance of computer systems uses programs called benchmarks. A benchmarking program runs a series of well-defined tests on the system and generates a score that represents the system's performance.

Benchmarks provide a specific, comparable and reproducible method of objectively measuring the performance of a computer system. Evaluating complete systems using performance-based benchmarks leads to more informed decisions.

Using benchmarks for PC procurement

PCMark 10 is an ideal benchmark for governments and enterprise organizations seeking a vendor-neutral solution. It provides accurate, relevant, impartial, and practical benchmark tests for specifying and comparing the performance of Windows PCs, notebooks, and tablets.

PCMark benchmarks are used by the governments of France, Germany, Northern Ireland, and Brazil as well as the European Commission.

Vendor-neutral development process

Futuremark is an independent developer that has been making industry standard benchmarks to a strict code of neutrality since 1997. We make the world's most widely-used performance tests for PCs, laptops, notebooks, tablets, and smartphones.

Futuremark creates benchmarks in cooperation with the world's leading technology companies using an open and transparent process that guarantees fair and neutral benchmark results.

Futuremark is part of UL, a global safety science company with more than a century of expertise and innovation in the fields of product safety testing, inspection and verification services.

UL partners with governments, regulators, businesses, manufacturers, and trade associations to play a key role in the development and harmonization of national and international standards.

Choosing a suitable benchmark test

PCMark 10 offers several benchmark tests. Each one is designed around a specific scenario. You should choose the test that best matches the intended audience for the device being tested.

PCMark 10 benchmark	The complete benchmark for the modern office. It is the ideal test for organizations that are evaluating PCs for a workforce with a range of performance needs.
PCMark 10 Express	A shorter benchmark test focused on basic work tasks. It is a good choice when tendering for PCs for general office use.
PCMark 10 Extended	A longer benchmark test covering a wider range of activities. It provides organizations with a complete assessment of system performance beyond typical office work tasks.

Each benchmark produces a score that you can use to compare systems. A higher scores indicates better performance. You'll also get detailed results and monitoring charts that provide a deeper understanding of performance during each workload.

When testing systems 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.

Good testing guide

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.

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.
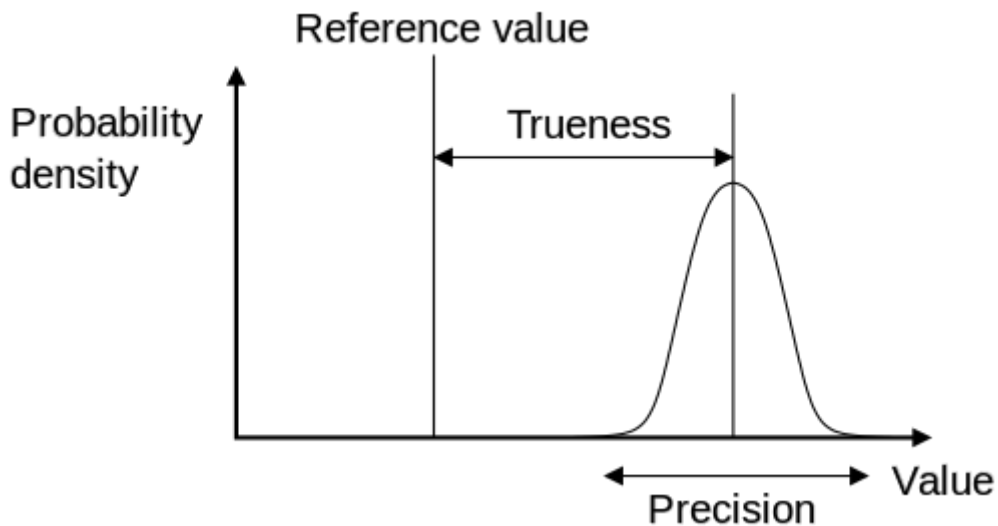
The precision of PCMark 10 scores is usually better than 3% when following the steps outlined in our good testing guide. This means that running the benchmark repeatedly on a consistently performing system in a well-controlled environment will produce scores that fall within a 3% range.

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

Latest version numbers

	Version
PCMark 10 application	1.0.1493
PCMark 10 benchmark	1.0
PCMark 10 Express benchmark	1.0
PCMark 10 Extended benchmark	1.0

Application version number

The application version number applies to the software as a whole. It changes often as we update the application 10 to add new features and ensure compatibility with the latest hardware. We recommend using the latest application version.

Benchmark version numbers

A benchmark version number is specific to a test. Benchmark version numbers change rarely and only when absolutely necessary to accommodate changes in third-party applications or bug fixes.

Comparing scores across versions

Futuremark guarantees that benchmark results are comparable across application versions provided that the major digit of the benchmark version number is the same as illustrated in the examples below.

Old benchmark version number	New benchmark version number	Comparing scores
1.0	1.1	The major digit of the version number is the same. Scores can be compared across versions.
1.0	2.0	The major digit of the version number has changed. Scores should not be compared across versions.

Minimum system requirements

	PCMark 10	PCMark 10 Express	PCMark 10 Extended
OS[2]	Windows 7 SP1 64-bit	Windows 7 SP1 64-bit[3]	Windows 7 SP1 64-bit
Processor	Dual core processor	Dual core processor	Dual core processor
Memory	4 GB	2 GB	4 GB
Graphics	DirectX 11 GPU	DirectX 11 GPU	DirectX 11 GPU with 1 GB memory
Display[4]	1920 × 1080	1280 × 720	1920 × 1080
Recommended display scaling factor[5]	100%	100%	100%
Storage	6 GB free space	6 GB free space	6 GB free space

---

[2] Including all available Windows updates.

[3] A 32-bit version is provided, but will not supported.

[4] Minimum supported resolution.

[5] Running the benchmark with a different DPI scaling than the recommended will affect score comparability and may affect the stability of the results on some hardware configurations.

Options screen

The Options screen settings apply to all PCMark 10 benchmark tests.

Register / Unregister

If you have a PCMark 10 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.

Language

Use the drop down to change the display language. The choices are:

- English
- German
- Simplified Chinese
- Russian

Validate result online

This option is only available in PCMark 10 Professional Edition where it is disabled by default. In PCMark 10 Basic and Advanced Editions, all results are validated online automatically.

Automatically hide results online

Check this box if you wish to keep your PCMark 10 test scores private. Hidden results are not visible to other users and do not appear in search results.

- PCMark 10 Basic Edition, disabled by default and cannot be selected.
- PCMark 10 Advanced Edition, disabled by default.
- PCMark 10 Professional Edition, selected by default.

Scan SystemInfo

SystemInfo is a component used in Futuremark 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 hardware 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.

Write detailed log

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

Benchmarks, test groups, and workloads

PCMark 10 uses a modular approach to build relevant tests around common end-user scenarios. There are three levels to this approach: benchmarks, test groups, and workloads.

Benchmarks

Benchmarks are the top-level starting point in PCMark 10. A benchmark is a test designed to reflect the performance requirements of a defined user group.

There are three benchmarks in the current version of PCMark 10.

- PCMark 10 benchmark – the complete benchmark for the modern office
- PCMark 10 Express - a shorter test focused on basic work tasks
- PCMark 10 Extended - a longer test covering a wider range of activities

Test groups

Each benchmark contains a number of test groups. A test group is a collection of workloads that share a common theme or purpose. There are four test groups in PCMark 10.

	Essentials	Productivity	Digital Content Creation	Gaming
PCMark 10	●	●	●	✕
PCMark 10 Express	●	●	✕	✕
PCMark 10 Extended	●	●	●	●

Workloads

Workloads are the low-level unit in PCMark 10. A workload is a test designed around a specific activity, task, or application. For example, the Web Browsing workload is designed to test performance while engaging in a number of typical web browsing tasks.

PCMark 10 benchmark

The PCMark 10 benchmark contains tests that cover the wide variety of work encountered in a modern office from everyday essentials and productivity applications to demanding work with digital media content. It is the ideal test for organizations that are evaluating PCs for a range of performance needs.

Benchmark	Test Groups	Workloads

Essentials → App Start-up, Web Browsing, Video Conferencing

Productivity → Writing, Spreadsheets

Digital Content Creation (DCC) → Photo Editing, Video Editing, Rendering and Visualization

PCMark 10 benchmark → Essentials, Productivity, Digital Content Creation (DCC)
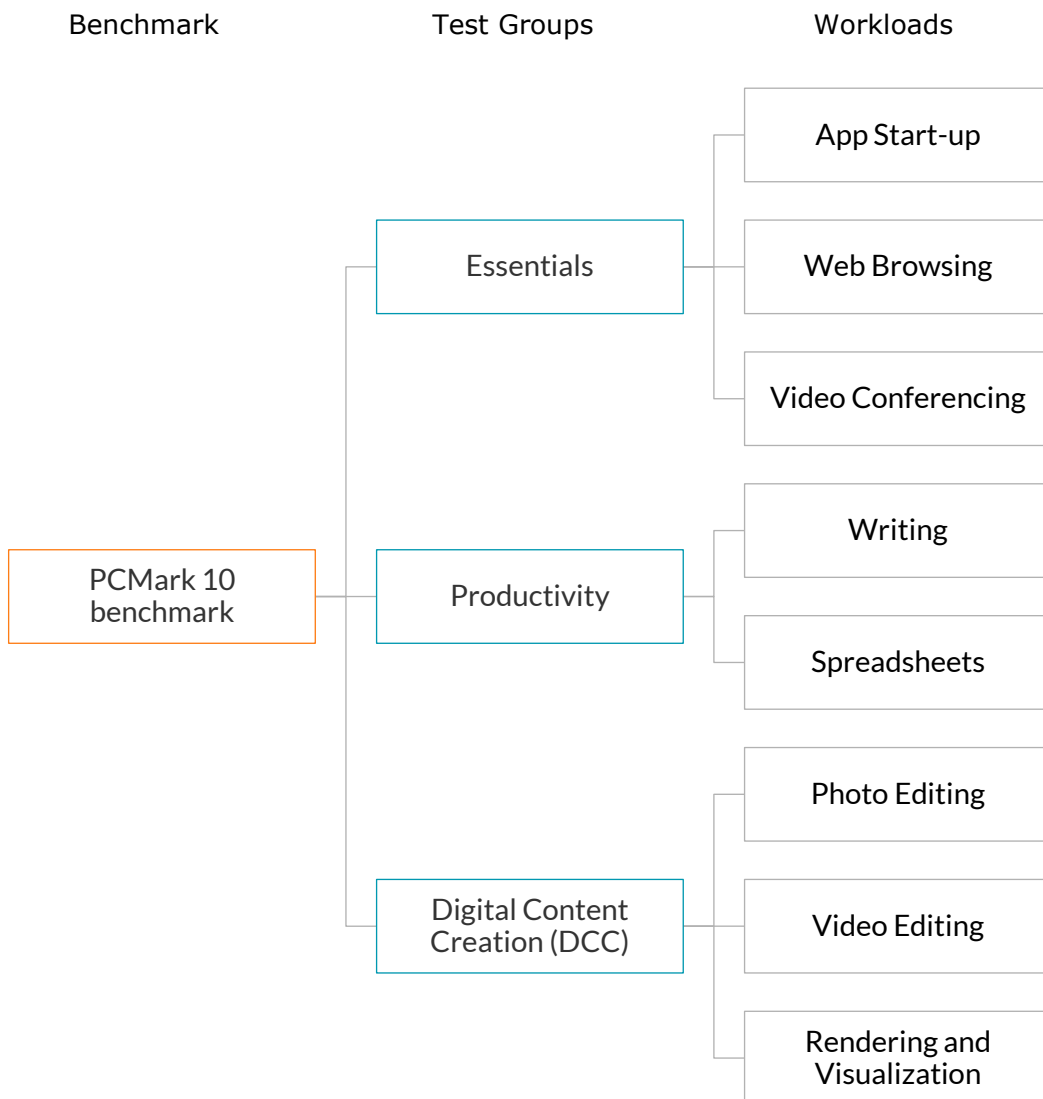
Scoring

Overall score

$$PCMark\ 10\ score = K * geomean(S_e, S_p, S_d)$$

Where:

$K = 0.717$ (to $scale\ the\ score\ to\ 5{,}000\ on\ the\ reference\ PC$)

$S_e = Essentials\ test\ group\ score$

$S_p = Productivity\ test\ group\ score$

$S_d = DCC\ group\ score$

Group scoring

$$Essentials\ test\ group\ score = geomean(E_1, E_2, E_3)$$

Where:

$E_1 = App\ Start\text{-}up\ score$

$E_2 = Web\ Browsing\ score$

$E_3 = Video\ Conferencing\ score$

$$Productivity\ test\ group\ score = geomean(P_1, P_2)$$

Where:

$P_1 = Writing\ score$

$P_2 = Spreadsheets\ score$

$$DCC\ test\ group\ score = geomean(D_1, D_2, D_3)$$

Where:

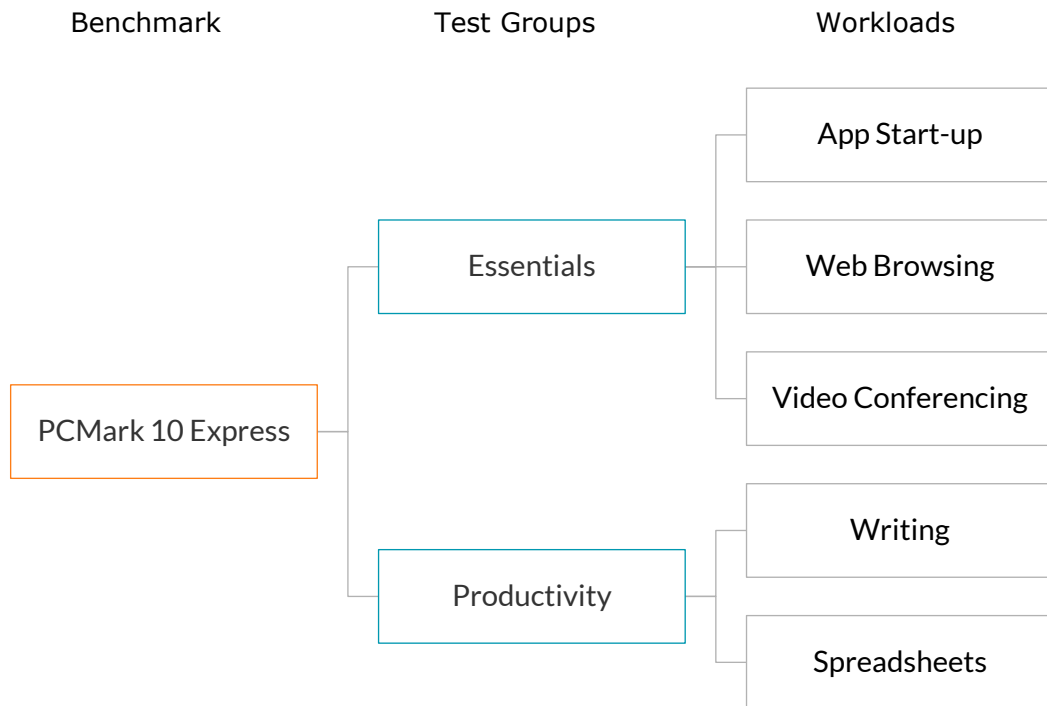$D_1 = Photo\ Editing\ score$

$D_2 = Video\ Editing\ score$

$D_3 = Rendering\ and\ Visualization\ score$

PCMark 10 Express benchmark

The PCMark 10 Express benchmark measures the performance of the types of application typically used by office workers in administration, sales, and manager roles.

Benchmark	Test Groups	Workloads

```
                                        ┌─────────────────┐
                                    ┌───│   App Start-up   │
                                    │    └─────────────────┘
                 ┌──────────────┐   │    ┌─────────────────┐
              ┌──│  Essentials  │───┼───│  Web Browsing    │
              │   └──────────────┘   │    └─────────────────┘
              │                      │    ┌─────────────────┐
┌──────────────────┐                └───│ Video Conferencing │
│ PCMark 10 Express │                     └─────────────────┘
└──────────────────┘                      ┌─────────────────┐
              │                       ┌───│     Writing      │
              │   ┌──────────────┐    │    └─────────────────┘
              └──│ Productivity │────┤    ┌─────────────────┐
                  └──────────────┘    └───│   Spreadsheets   │
                                          └─────────────────┘
```

Scoring

Overall scoring

$$PCMark\ 10\ Express\ score = K * geomean(S_e, S_p)$$

Where:

$K = 0.605\ (to\ scale\ the\ score\ to\ 5,000\ on\ the\ reference\ PC)$

$S_e = Essentials\ test\ group\ score$

$S_p = Productivity\ test\ group\ score$

Group scoring

$$Essentials\ test\ group\ score = geomean(E_1, E_2, E_3)$$

Where:

$E_1 = App\ Start\text{-}up\ score$

$E_2 = Web\ Browsing\ score$

$E_3 = Video\ Conferencing\ score$

$$Productivity\ test\ group\ score = geomean(P_1, P_2)$$
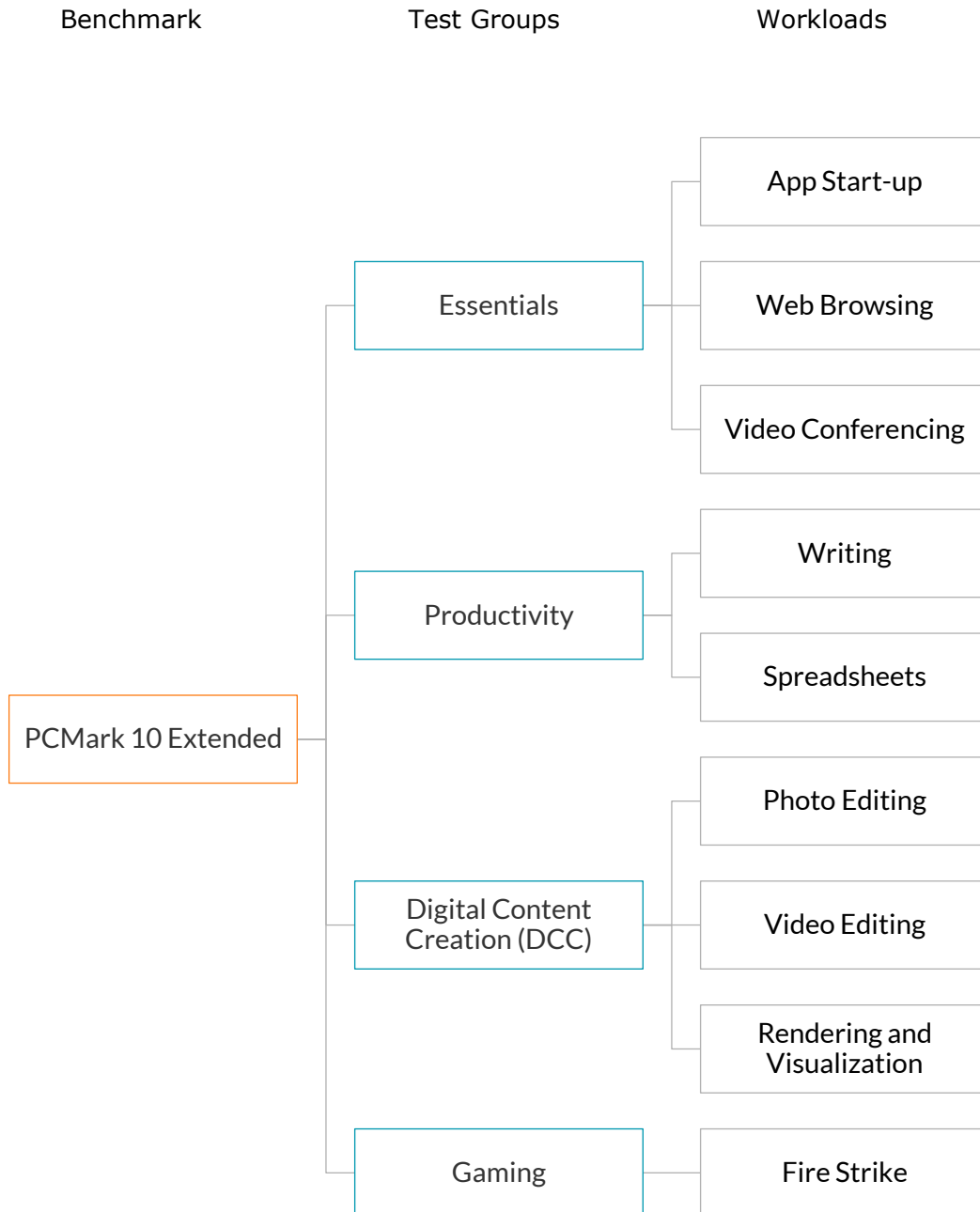
Where:

$P_1 = Writing\ score$

$P_2 = Spreadsheets\ score$

PCMark 10 Extended benchmark

The PCMark 10 Extended benchmark in PCMark 10 is a complete system test for all types of Windows PC. It includes all workloads from all four test groups to give you the most comprehensive view of your system's performance.

Benchmark   Test Groups   Workloads

Benchmark	Test Groups	Workloads
PCMark 10 Extended	Essentials	App Start-up
		Web Browsing
		Video Conferencing
	Productivity	Writing
		Spreadsheets
	Digital Content Creation (DCC)	Photo Editing
		Video Editing
		Rendering and Visualization
	Gaming	Fire Strike

Scoring

Overall scoring

$$PCMark\ 10\ Extended\ score = K * geomean(S_e, S_p, S_d, S_g)$$

Where:

$K = 0.780\ (to\ scale\ the\ score\ to\ 5{,}000\ on\ the\ reference\ PC)$

$S_e = Essentials\ group\ score$

$S_p = Productivity\ group\ score$

$S_d = DCC\ group\ score$

$S_g = Gaming\ group\ score$

Group scoring

$$Essentials\ test\ group\ score = geomean(E_1, E_2, E_3)$$

Where:

$E_1 = App\ Start\text{-}up\ score$

$E_2 = Web\ Browsing\ score$

$E_3 = Video\ Conferencing\ score$

$$Productivity\ test\ group\ score = geomean(P_1, P_2)$$

Where:

$P_1 = Writing\ score$

$P_2 = Spreadsheets\ score$

$$DCC\ test\ group\ score = geomean(D_1, D_2, D_3)$$

Where:

$D_1 = Photo\ Editing\ score$

$D_2 = Video\ Editing\ score$

$D_3 = Rendering\ and\ Visualization\ score$

$$Gaming\ score = Fire\ Strike\ score = K * \frac{Wgraphics + Wphysics + Wcombined}{\frac{Wgraphics}{Sgraphics} + \frac{Wphysics}{Sphysics} + \frac{Wcombined}{Scombined}}$$

Where:

K = 0.834 (to $scale\ the\ score\ to$ 5,000 $on\ the\ reference\ PC$)

$Wgraphics$	=	The Graphics score weight, set to 0.75
$Wphysics$	=	The Physics score weight, set to 0.15
$Wcombined$	=	The Combined score weight, set to 0.10
$Sgraphics$	=	Graphics score
$Sphysics$	=	Physics score
$Scombined$	=	Combined score

Please see the Workloads section for the score formula for each workload.

Custom runs

Expert users can set up and run custom benchmark tests using any combination of workloads.

A custom benchmark run will return the results from each workload and display hardware performance monitoring charts, but you will not get an overall benchmark score.

Essentials test group

The Essentials test group contains workloads that are relevant to the majority of desktop and laptop Windows PC users. It includes the following workloads:

1. App Start-up
2. Web Browsing
3. Video Conferencing

App Start-up

It is frustrating when the applications you use every day are slow to start.

The App Start-up workload measures hardware performance when launching a number of real applications chosen to represent the types of app that people use day in, day out. The apps were chosen to cover a range of categories – web browser, test editor, image editor - and a spectrum of complexity – from small, lightweight apps to complex apps with lots of DLLs to load.

- Chromium web browser
- Firefox web browser
- LibreOffice Writer word processing program
- GIMP image manipulation program

The applications are included in the PCMark 10 installation package.

Implementation

The test has three parts: initialization, warm start, and cold start.

For the initialization part, all the applications are started once then closed.

For each application in the warm start part of the test:

1. Start the application.
2. Measure the time taken until the application is responsive.
3. Close the application.
4. Repeat from step 1 five times.
5. The result is the geomean of the five runs.

For each application in the cold start part of the test:

1. Flush the system cache.
2. Start the application.
3. Measure the time taken until the application is responsive.
4. Close the application.
5. Repeat from step 1 five times.
6. The result is the geomean of the five runs.

Scoring

$$App\ Start\text{-}up\ score = K * \frac{1}{geomean(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8)}$$

Where:

$$K = scoring\ coefficient = 15823$$

Result	Definition	Unit	Typical range
R_1	Writer warm start	s	0.9-1.8
R_2	Writer cold start	s	3.0-8.0
R_3	GIMP warm start	s	1.8-3.2
R_4	GIMP cold start	s	4.5-9.1
R_5	Chromium warm start	s	0.17-0.35
R_6	Chromium cold start	s	1.3-3.0
R_7	Firefox warm start	s	0.86-1.8
R_8	Firefox cold start	s	2.0-5.4

Web Browsing

This test simulates high-level use cases where the user browses common websites with a web browser application. The test uses the following website archetypes and use cases: social media, online shopping, map, video, and static web page.

Implementation

The Web Browsing test utilizes two browsers: Firefox and Google Chromium. Any other browsers possibly installed in the system will not affect the benchmark.

The content is served with a local lightweight web server that is embedded into the benchmark. The content is custom made for the benchmark and represents common web sites.

The web pages are shown using both browsers, except the video page that is only run on Chromium. All the pages are run 2 times in both browsers.

Workloads

Social media

The social media workload simulates usage of social media platforms and includes the following tasks:

- Navigates to and load a social media site.
- The page updates the news feed with new content.
- The page updates the feed again.

The workload measures the loading time of the page content and of the feed update.

$$Social\ media\ page\ load = geomean\left(\frac{M_1}{1000}, \frac{M_2}{1000}\right)$$

Where:

$$M_1 = dbg\_pcm10\_web\_chromium\_some\_rendertime$$

$$M_2 = dbg\_pcm10\_web\_firefox\_some\_rendertime$$

$$Social\ media\ feed\ update = geomean\left(\frac{M_3}{1000}, \frac{M_4}{1000}\right)$$

Where:

$$M_1 = dbg\_pcm10\_web\_chromium\_some\_updatetime$$

$$M_2 = dbg\_pcm10\_web\_firefox\_some\_updatetime$$

Online shopping

The online shopping workload simulates an online store. The workload performs the following tasks:

- View and zoom in on high resolution images of shopping items.
- View 3D models of items.

The workload measures the time to view an image, load a 3D object, and animate a 3D object.

$$Shop\ view\ image = (Min(60, M_5))$$

Where:

$$M_5 = dbg\_pcm10\_web\_chromium\_webshop\_zoom\_fps$$

$$Shop\ load\ 3D\ object = geomean\left(\frac{M_6}{1000}, \frac{M_7}{1000}\right)$$

Where:

$$M_6 = dbg\_pcm10\_web\_chromium\_shop\_modelparsetime$$

$$M_7 = dbg\_pcm10\_web\_firefox\_shop\_modelparsetime$$

$$Shop\ animate\ 3D\ object = geomean(Min(300, M_8), Min(300, M_9))$$

Where:

$$M_8 = dbg\_pcm10\_web\_chromium\_shop\_fps$$

$$M_9 = dbg\_pcm10\_web\_firefox\_shop\_fps$$

Map

The map workload simulates the visualization of information on a map. The workload includes the following tasks:

- Navigate to and load a map site.
- The page adds useful graphics such as traffic information.
- Zoom in on the map.

The workload measures the time it takes to update the information on the map and the time to zoom in.

$$Map\ infographics\ update = geomean\left(\frac{M_{10}}{1000}, \frac{M_{11}}{1000}, \frac{M_{12}}{1000}, \frac{M_{13}}{1000}\right)$$

Where:

$M_{10} = dbg\_pcm10\_web\_chromium\_realestate\_heatmapLoad$

$M_{11} = dbg\_pcm10\_web\_firefox\_realestate\_heatmapLoad$

$M_{12} = dbg\_pcm10\_web\_chromium\_realestate\_markers$

$M_{13} = dbg\_pcm10\_web\_firefox\_realestate\_markers$

$$Map\ zooming = geomean\left(\frac{M_{14}}{1000}, \frac{M_{15}}{1000}, \frac{M_{16}}{1000}, \frac{M_{17}}{1000}, \frac{M_{18}}{1000}, \frac{M_{19}}{1000}\right)$$

Where:

$M_{14} = dbg\_pcm10\_web\_chromium\_realestate\_tileLoad01$

$M_{15} = dbg\_pcm10\_web\_chromium\_realestate\_tileLoad02$

$M_{16} = dbg\_pcm10\_web\_chromium\_realestate\_tileLoad03$

$M_{17} = dbg\_pcm10\_web\_firefox\_realestate\_tileLoad01$

$M_{18} = dbg\_pcm10\_web\_firefox\_realestate\_tileLoad02$

$M_{19} = dbg\_pcm10\_web\_firefox\_realestate\_tileLoad03$

Video

The video workload simulates online video playback. The workload views a selection of HD and 4K UHD video clips using two codecs. The video workload measures the frame rate of the video playback.

$$Video\ H.264\ 1920 \times 1080 = M_{20}$$

Where:

$M_{20} = dbg\_pcm10\_web\_chromium\_video\_video\_fhd\_mp4$

$$Video\ H.264\ 3840 \times 2160 = M_{21}$$

Where:

$$M_{21} = dbg\_pcm10\_web\_chromium\_video\_video\_uhd\_mp4$$

$$Video\ H.264\ 3840 \times 2160 = M_{21}$$

Where:

$$M_{21} = dbg\_pcm10\_web\_chromium\_video\_video\_uhd\_mp4$$

$$Video\ VP9\ 1920 \times 1080 = M_{22}$$

Where:

$$M_{22} = dbg\_pcm10\_web\_chromium\_video\_video\_fhd\_webm$$

$$Video\ VP9\ 3840 \times 2160 = M_{23}$$

Where:

$$M_{23} = dbg\_pcm10\_web\_chromium\_video\_video\_uhd\_webm$$

Scoring

The Web Browsing score formula uses a geomean of the workloads to calculate the overall score.

$$Web\ Borwsing\ score = K * geomean\left(\frac{1}{R_1}, \frac{1}{R_2}, R_3, \frac{1}{R_4}, R_5, \frac{1}{R_6}, \frac{1}{R_7}, R_8, R_9, R_{10}, R_{11}\right)$$

Where:

$$K = scoring\ coefficient = 419$$

Result	Definition	Unit	Typical range
R_1	Social media page load	s	0.10-0.18
R_2	Social media feed update	s	0.12-0.21

Result	Definition	Unit	Typical range
R_3	Shop view image	FPS	31-60
R_4	Shop load 3D object	s	1.2-1.9
R_5	Shop animate 3D object	FPS	100-300
R_6	Map infographics update	s	0.10-0.24
R_7	Map zooming	s	0.02-0.08
R_8	Video H.264 1920 × 1080	FPS	30
R_9	Video H.264 3840 × 2160	FPS	28-30
R_{10}	Video VP9 1920 × 1080	FPS	30
R_{11}	Video VP9 3840 × 2160	FPS	17-30

Video Conferencing

This test models use cases of video conferencing applications. The test uses two scenarios: a private call and a group call.

Implementation

The Video Conferencing test uses Windows Media Foundation for video playback and encoding. Face detection is implemented using library OpenCV (http://opencv.org).

The Video Conferencing test supports OpenCL. The benchmark application selects a preferred OpenCL device to use.

Face detection is made by using cascade classifier haarcascade_frontalface_alt.xml.

Parameters for one-to-one video conferencing: scale factor 1.1, min neighbors 10, min size 110x110 and max size 300x300.

Parameters for group video conferencing: scale factor 1.05, min neighbors 5, min size 110x110 and max size 300x300.

 Part 1: one-to-one video conferencing with basic quality video

- Encode: 720p, 30 FPS, H.264 video, bitrate 14380 kb/s
- Playback: 720p, 30 FPS, H.264 video, bitrate 11773 kb/s
- Two video streams (a local and a remote one)
- Both streams are displayed on screen downscaled to a fixed resolution window.
- Face detection performed on the local stream
- Stage 1 - CPU:
  - Code path: x86/x64
  - Runtime: 10s
- Stage 1 - OpenCL:
  - Condition to run: a suitable OpenCL device must be available
  - Code path: OpenCL
  - Runtime: 10s

Part 2: group video conferencing with high quality outgoing video

- Encode: 1080p, 30 FPS, H.264 video, bitrate 12731 kb/s
- Playbacks: 720p, 30 FPS, H.264 video, bitrate 10152 - 12251 kb/s
- Four streams (a local and three remote ones)
- All streams are displayed on screen downscaled to a fixed resolution window.
- Face detection performed on the local stream
- Stage 2 - CPU:

- Code path: x86/x64
- Runtime: 10s
- Stage 2 - OpenCL:
  - Condition to run: a suitable OpenCL device must be available
  - Code path: OpenCL
  - Runtime: 10s

Workloads

In both the private and group call scenarios, the sent video stream is processed in following manner:

- Caller face location is detected in periodic intervals
- The perceived quality of each frame is improved based on the face location information by blurring the background.

Private call scenario

In the private call scenario, the test runs a 1-to-1 call at a resolution of 1280 × 720 at 30 FPS. The workload measures the frame rate of the video call.

$$Playback\ private\ CPU = M_1$$

Where:

$$M_1 = dbg\_pcm10\_chat\_play\_private\_average\_frame\_rate\_cpu$$

$$Playback\ private\ OCL = M_2$$

Where:

$$M_2 = dbg\_pcm10\_chat\_play\_private\_average\_frame\_rate\_ocl$$

$$Encode\ private\ OCL = \frac{M_3}{M_4}$$

Where:

$$M_3 = dbg\_pcm10\_chat\_play\_private\_average\_frame\_rate\_ocl$$

$$M_4 = dbg\_pcm10\_chat\_encode\_private\_elapsed\_ocl$$

$$Face\ detect\ private\ CPU = \frac{1000}{M_5}$$

Where:

$$M_5$$
$$= dbg\_pcm10\_chat\_encode\_private\_facedetect\_average\_time\_per\_frame\_cpu$$

$$Face\ detect\ private\ OCL = \frac{1000}{M_6}$$

Where:

$$M_6$$
$$= dbg\_pcm10\_chat\_encode\_private\_facedetect\_average\_time\_per\_frame\_ocl$$

Group call scenario

In the group call scenario, the call has four participants and the video resolution is 1920 × 1080 at 30 FPS. The workload measures the frame rate of the video call.

$$Playback\ group\ CPU = geomean(M_7, M_8, M_9)$$

Where:

$$M_7 = dbg\_pcm10\_chat\_play\_private\_average\_frame\_rate\_cpu\_p1$$

$$M_8 = dbg\_pcm10\_chat\_play\_private\_average\_frame\_rate\_cpu\_p2$$

$$M_9 = dbg\_pcm10\_chat\_play\_private\_average\_frame\_rate\_cpu\_p3$$

$$Playback\ group\ OCL = geomean(M_{10}, M_{11}, M_{12})$$

Where:

$$M_{10} = dbg\_pcm10\_chat\_play\_group\_average\_frame\_rate\_cpu\_p1$$

$$M_{11} = dbg\_pcm10\_chat\_play\_group\_average\_frame\_rate\_cpu\_p2$$

$$M_{12} = dbg\_pcm10\_chat\_play\_group\_average\_frame\_rate\_cpu\_p3$$

$$Encode\ group\ OCL = \frac{M_{13}}{M_{14}}$$

Where:

$$M_{13} = dbg\_pcm10\_chat\_encode\_group\_sink\_frames\_ocl$$

$$M_{14} = dbg\_pcm10\_chat\_encode\_group\_elapsed\_ocl$$

$$Face\ detect\ group\ CPU = \frac{1000}{M_{15}}$$

Where:

M_{15}
$= dbg\_pcm10\_chat\_encode\_group\_facedetect\_average\_time\_per\_frame\_cpu$

$$Face\ detect\ group\ OCL = \frac{1000}{M_{16}}$$

Where:

M_{16}
$= dbg\_pcm10\_chat\_encode\_group\_facedetect\_average\_time\_per\_frame\_ocl$

Scoring

The Video Conferencing score formula uses a geomean of the workloads to calculate the overall score.

$$Video\ Conferencing\ score = K * geomean(R_1, R_2^*, R_3)$$

*The geometric mean weight of R_2 is 2.

Where:

$K = scoring\ coefficient = 275$

$R_1 = Overall\ playback\ rate = geomean(A_1, A_2, A_{3,}A_4)$

$R_2 = Overall\ encode\ rate = geomean(A_5, A_6)$

$R_3 = Overall\ face\ detect\ rate = geomean(A_7, A_8, A_9, A_{10})$

Where:

Result	Definition	Unit	Typical range
A_1	Playback private CPU	FPS	30

Result	Definition	Unit	Typical range
A_2	Playback private OCL	FPS	30
A_3	Playback group CPU	FPS	30
A_4	Playback group OCL	FPS	30
A_5	Encode private OCL	FPS	22-30
A_6	Encode group OCL	FPS	15-23
A_7	Face detect private CPU	FPS	30-71
A_8	Face detect private OCL	FPS	51-97
A_9	Face detect group CPU	FPS	5.6-13
A_{10}	Face detect group OCL	FPS	11-31

Productivity test group

Productivity test group tests office productivity application performance. It includes the following tests:

1. Writing
2. Spreadsheets

Writing

The Writing test models common use cases with text processing applications.

Implementation

The test uses LibreOffice Writer application and is implemented using AutoIt3 scripts.

In the copy and cut tests, the operation is repeated ten times to reduce random error. The secondary scores described in the Workload sub-chapter are then based on the geometric mean of the ten repeats.

Workloads

The Writing test simulates the work with documents. The workloads performs the following 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

The workloads measure the time it takes to load the documents, save the file, add pictures, and edit the document.

$$Load\ document = geomean(M_1, M_2)$$

Where:

$$M_1 = dbg\_pcm10\_writing\_display\_document\_source$$

$$M_2 = dbg\_pcm10\_writing\_display\_document\_destination$$

$$Save\ document = geomean(M_3, M_4, M_5, M_6)$$

Where:

$$M_3 = dbg\_pcm10\_writing\_save\_document\_as$$

$$M_4 = dbg\_pcm10\_writing\_save\_document\_1$$

$$M_5 = dbg\_pcm10\_writing\_save\_document\_2$$

$$M_6 = dbg\_pcm10\_writing\_save\_document\_3$$

$$Add\ pictures\ to\ document = geomean(M_7, M_8, M_9, M_{10}, M_{11})$$

Where:

$$M_7 = dbg\_pcm10\_writing\_editing\_add\_image\_0$$

$$M_8 = dbg\_pcm10\_writing\_editing\_add\_image\_1$$

$$M_9 = dbg\_pcm10\_writing\_editing\_add\_image\_2$$

$$M_{10} = dbg\_pcm10\_writing\_editing\_add\_image\_3$$

$$M_{11} = dbg\_pcm10\_writing\_editing\_add\_image\_3$$

$$Copy\ and\ paste$$
$$= Max(0.12, geomean(M_{12}, M_{13}, M_{14}, M_{15}, M_{16}, M_{17}, M_{18}, M_{19}, M_{20}, M_{21}))$$

Where:

$$M_{12} = dbg\_pcm10\_writing\_editing\_src\_copy\_0$$

$$M_{13} = dbg\_pcm10\_writing\_editing\_src\_copy\_1$$

$$M_{14} = dbg\_pcm10\_writing\_editing\_src\_copy\_2$$

$$M_{15} = dbg\_pcm10\_writing\_editing\_src\_copy\_3$$

$$M_{16} = dbg\_pcm10\_writing\_editing\_src\_copy\_4$$

$$M_{17} = dbg\_pcm10\_writing\_editing\_src\_copy\_5$$

$$M_{18} = dbg\_pcm10\_writing\_editing\_src\_copy\_6$$

$$M_{19} = dbg\_pcm10\_writing\_editing\_src\_copy\_7$$

$$M_{20} = dbg\_pcm10\_writing\_editing\_src\_copy\_8$$

$$M_{21} = dbg\_pcm10\_writing\_editing\_src\_copy\_9$$

$$Copy\ and\ paste$$
$$= Max(0.3, geomean(M_{22}, M_{23}, M_{24}, M_{25}, M_{26}, M_{27}, M_{28}, M_{29}, M_{30}, M_{31}))$$

Where:

$$M_{22} = dbg\_pcm10\_writing\_editing\_dest\_cut\_0$$

$$M_{23} = dbg\_pcm10\_writing\_editing\_dest\_cut\_1$$

$$M_{24} = dbg\_pcm10\_writing\_editing\_dest\_cut\_2$$

$$M_{25} = dbg\_pcm10\_writing\_editing\_dest\_cut\_3$$

$$M_{26} = dbg\_pcm10\_writing\_editing\_dest\_cut\_4$$

$$M_{27} = dbg\_pcm10\_writing\_editing\_dest\_cut\_5$$

$$M_{28} = dbg\_pcm10\_writing\_editing\_dest\_cut\_6$$

$$M_{29} = dbg\_pcm10\_writing\_editing\_dest\_cut\_7$$

$$M_{30} = dbg\_pcm10\_writing\_editing\_dest\_cut\_8$$

$$M_{31} = dbg\_pcm10\_writing\_editing\_dest\_cut\_9$$

Scoring

The Writing test score formula uses a geomean of the workloads to calculate the overall score.

$$Writing\ score = K * \frac{1}{geomean(R_1, R_2, R_3, R_4)}$$

Where:

$$R_3 = Overall\ copy\ and\ cut = geomean(R_5, R_6)$$

Where:

$$K = scoring\ coefficient = 4093$$

Result	Definition	Unit	Typical range
R_1	Load document	s	0.9-1.6
R_2	Save document	s	0.86-1.8
R_4	Add pictures to document	s	0.52-0.74

Result	Definition	Unit	Typical range
R_5	Copy and paste	s	0.12-0.28
R_6	Cut and paste	s	0.30-0.85

Spreadsheets

The Spreadsheets test models use cases for a spreadsheet application. The use of spreadsheets is very varied, ranging from writing simple shopping lists to processing massive data sheets. We model uses in two distinct categories: common use and power use.

Implementation

The Spreadsheets test uses a build of LibreOffice Calc (http://www.libreoffice.org) that ships with the benchmark. The application is scripted to execute tasks like document loading, saving, editing data, editing formulas and calculating.

The Spreadsheets test supports OpenCL. The benchmark application selects a preferred OpenCL device to use.

The Spreadsheets test is implemented using AutoIt3 scripts.

Part 1: overall application usage

- Stage 1:
  - Code path: x86/x64
  - Test sheet:
    - The test used is similar to the spreadsheet test in PCMark 8.
    - Compute load scaled down considerably to get consistent runtimes also on low end systems.

Part 2: calculation

- The test sheets used are available in the LibreOffice repository: https://gerrit.libreoffice.org/gitweb?p=benchmark.git;a=tree
- Stage 2 - CPU:
  - Code path: x86/x64
  - Test sheets:
    - Building Design
    - Stock History
- Stage 2 - OpenCL
  - Code path: OpenCL
  - Test sheets:
    - Energy market in different countries
    - Monte Carlo Black Scholes option pricing

PCMark 10 uses several test sheets that contain data for the following scenarios:

- Comparing different forms of energy based on consumption and the impact of one form of energy on the rest of the forms.
- Computation of Envelope Thermal Transfer Value for building designs to assess the thermal performance and energy conservation design factors.
- Computing short-term fluctuations of stock values and highlighting long-term trends to guide investors.
- Calculation of theoretical call and put price using key determinants of an option's price: stock price, strike price, volatility, time to expiration, and short-term interest rate.

Workloads

Common use scenario

The common use scenario simulates the work with spreadsheets applications. The workloads performs the following tasks:

1. Start LibreOffice 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
5. Copy data from the source workbook to the destination workbook to cells that do not trigger formula evaluation
6. Copy formulas from inside the destination workbook so that data evaluation for the data copied in task 5 is triggered
7. Copy more data from the source workbook to the destination workbook to cells that trigger formula evaluation
8. Plug specific values to three individual cells triggering formula evaluation
9. Save the destination workbook into a new file

The workload measures the time it takes to open the document, copy and compute, copy plain data, copy formulas, editing cells, and saving the document.

Power use scenario

The power use scenario simulates the work with more complex spreadsheets in a spreadsheet application. The workloads performs the following tasks:

1. Load sheets with advanced formulas and big data sets
2. Recalculate data

The workload measures the time it takes to load the documents and recalculate the data.

Scoring

The Spreadsheets test score formula uses a geomean of the workloads to calculate the overall score.

$$Spreadsheet\ score = K * \frac{1}{geomean(R_1, R_2)}$$

Where:

$$K = scoring\ coefficient = 11159$$

$$R_1 = Overall\ common\ use = geomean(A_1, A_2, A_{3,}A_4, A_5, A_6, A_7)$$

$$R_2 = Overall\ power\ use = weighted\ geomean(A_8^*, A_9^*, A_{10}, A_{11})$$

*The geometric mean weight is specified in the table below.

Result	Definition	Unit	Typical range	Geometric mean weight
A_1	Open document	s	1.2-1.7	
A_2	Copy data and compute	s	1.5-2.0	-
A_3	Copy plain data	s	2.0-2.6	-
A_4	Copy formulas	s	0.74-0.89	-
A_5	Copy data and compute 2	s	2.5-3.3	-
A_6	Edit cells	s	0.71-1.05	-
A_7	Save document	s	1.3-2.0	-
A_8	Recalculate Building design CPU	s	0.55-0.80	2
A_9	Recalculate Stock history CPU	s	0.96-1.3	2

Result	Definition	Unit	Typical range	Geometric mean weight
A_{10}	Recalculate Monte Carlo OCL	s	1.0-15	1
A_{11}	Recalculate Energy market OCL	s	0.8-5.6	1

Digital Content Creation test group

Digital Content Creation test group tests performance in video, photo and 3D content creation. It includes the following tests:

1. Photo Editing
2. Video Editing
3. Rendering and Visualization

Photo Editing

The Photo Editing test models use cases with photo editing application.

Implementation

The Photo Editing test uses the ImageMagick library. The test uses binaries built by Futuremark.

The Photo Editing test supports OpenCL. The benchmark application selects a preferred OpenCL device for the ImageMagick library to use.

	Camera	File size	Resolution
Interactive RAW	Fujifilm X-E1	24.9 MB	4952 × 3288
Batch 1 RAW	Canon EOS 5D	15.8 MB	4386 × 2920
Batch 2 RAW	Nikon D600	20.5 MB	6034 × 4028
Batch 3 RAW	Nikon D800	72.2 MB	7378 × 4924
Batch 4 RAW	Canon EOS 5D	13.5 MB	4386 × 2920
Batch 5 RAW	Olympus E-PL7	14.5 MB	4640 × 3472
Batch 6 RAW	Sony ILCE-7	23.8 MB	6024 × 4024
Batch 7 JPG	Nikon D3100	6.9 MB	4608 × 3072
Batch 8 JPG	Nikon D3	5.5 MB	4256 × 2832
Output PNG		27.8 MB	4952 × 3288
Output JPEG		7.2–8.9 MB	4952 × 3288

Following filters are executed on CPU:

- color adjusting
- unsharp mask 1
- noise adding

- thumbnail loading

Following filters are executed on OCL:

- gaussian blur
- unsharp mask 2
- local contrast
- wavelet denoise
- batch transformation

Workloads

Interactive scenario

The interactive use scenario simulates editing a photo in an image manipulation program. The workloads performs the following tasks:

1. Load and display a source image into the adjustment view.
2. Apply brightness, contrast, saturation, unsharp mask, Gaussian noise, Gaussian blur, a further unsharp mask, local contrast and wavelet denoise to the source image via sliders in the user interface and display the resulting image in the adjustment view. Each slider is moved 2-5 times, depending on the operation. After each filtering pass constituting a secondary result, each image is saved on disk in JPEG and PNG formats.

The workload measures the time it takes to load images, apply filters and save the images in each format.

$$Color\ adjusting\ CPU = \ M_3 + \ M_4 + M_5 + M_6 + M_7$$

Where:

$$M_3 = BrightnessContrastImage(brightness\ 1 - 9, 3\ step)$$

$$M_4 = BrightnessContrastImage(brightness\ 8 - 1.77, 3\ step)$$

$$M_5 = BrightnessContrastImage(contrast\ 1 - 27.34, 4\ step)$$

$$M_6 = ModulateImage(saturation\ 101 - 99, 2\ step)$$

$$M_7 = ModulateImage(saturation\ 101 - 112, 4\ step)$$

$$Noise\ adding\ CPU = \ M_8$$

Where:

$$M_8 = AddNoiseImage(noistype\ GaussianNoise)$$

$$Gaussian\ blur\ OCL = M_9 + M_{10}$$

Where:

$$M_9 = GaussianBlurImage(radius\ 2 - 0.3, 5\ step)$$

$$M_9 = GaussianBlurImage(sigma\ 1 - 0.15, 5\ step)$$

$$Local\ contrast\ OCL = M_{11} + M_{12}$$

Where:

$$M_{11} = LocalContrastImage(radius\ 20 - 100, 5\ step)$$

$$M_{12} = LocalContrastImage(amount\ 25 - 75, 5\ step)$$

$$Wavelet\ denoise\ OCL = M_{13}$$

Where:

$$M_{13} = WaveletDenoiseImage(threshold\ 1 - 10, 5\ step)$$

$$Unsharp\ mask\ 1\ CPU = M_{14} + M_{15} + M_{16} + M_{17}$$

Where:

$$M_{14} = UnsharpMaskImage(radius\ 1 - 8, 5\ step)$$

$$M_{15} = UnsharpMaskImage(sigma\ 1 - 4, 5\ step)$$

$$M_{16} = UnsharpMaskImage(amount\ 99 - 32, 5\ step)$$

$$M_{17} = UnsharpMaskImage(threshold\ 0.2 - 3, 5\ step)$$

$$Unsharp\ mask\ 2\ OCL = M_{18} + M_{19} + M_{20} + M_{21}$$

Where:

$$M_{18} = UnsharpMaskImage(radius\ 1 - 2.6, 5\ step)$$

$$M_{19} = UnsharpMaskImage(sigma\ 1 - 1.3, 5\ step)$$

$$M_{20} = UnsharpMaskImage(amount\ 99 - 35, 5\ step)$$

$$M_{21} = UnsharpMaskImage(threshold\ 1 - 2, 5\ step)$$

$$Save\ PNG\ =\ M_{22}$$

Where:

$$M_{22} = Sum\ of\ save\ times\ to\ png$$

$$Save\ JPEG\ =\ M_{23}$$

Where:

$$M_{23} = Sum\ of\ save\ times\ to\ jpeg$$

Batch processing scenario

The batch processing scenario simulates editing a group of photos in an image manipulation program. The workloads performs the following tasks:

1. Load each thumbnails one at a time into a preview matrix
2. Apply brightness, contrast, saturation, unsharp mask, Gaussian noise, Gaussian blur, a further unsharp mask, local contrast and wavelet denoise to all of the original images.
3. Continue to next image.

The workload measures the time it takes to load thumbnails, apply filters and save the images in each format.

$$Thumbnail\ loading\ CPU\ =\ geomean(M_1, M_2)$$

Where:

$$M_1 = geomean\ of\ 8\ image\ file\ load\ times$$

$$M_2 = geomean\ of\ the\ resize\ time\ of\ 8\ images\ to\ a\ thumbnail$$

And where:

The load time of the files is the following measurement: *dbg_photo_load_cpu*.

The resize time of the files is the following measurement: *dbg_photo_resize_cpu*.

$$Batch\ transformation\ OCL\ =\ M_3 + M_4 + M_5 + M_6 + M_7 + M_8 + M_9 + M_{10}$$

Where:

$$M_3 = BrightnessContrastImage(brightness\ 1.77, contrast\ 27.34)\ )$$

$$M_4 = ModulateImage(saturation\ 112)$$

$$M_5 = UnsharpMaskImage(radius\ 8, sigma\ 4, amount\ 32, threshold\ 3)$$

$$M_6 = AddNoiseImage(noistype\ GaussianNoise)$$

$$M_7 = GaussianBlurImage(radius\ 0.3, sigma\ 0.15)$$

$$M_8 = UnsharpMaskImage(radius\ 2.6, sigma\ 1.3, amount\ 35, threshold\ 2)$$

$$M_9 = LocalContrastImage(radius\ 50, amount\ 20)$$

$$M_{10} = WaveletDenoiseImage(threshold\ 10, softness\ 0)$$

Scoring

The Photo Editing test score formula uses a geomean of the workloads to calculate the overall score.

$$Photo\ Editing\ score = K * \frac{1}{geomean(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9)}$$

Where:

$$K = scoring\ coefficient = 14352$$

$$R_3 = Unsharp = geomean(A_1, A_2)$$

$$R_9 = Save = geomean(A_3, A_4)$$

And where:

Result	Definition	Unit	Typical range
R_1	Thumbnail loading CPU	s	0.32-0.70
R_2	Color adjusting CPU	s	4.9-10
R_4	Noise adding CPU	s	0.49-1.2
R_5	Gaussian blur OCL	s	0.60-3.0
R_6	Local contrast OCL	s	4.0-38
R_7	Wavelet denoise OCL	s	1.3-12

Result	Definition	Unit	Typical range
R_8	Batch transformation OCL	s	8.5-78
A_1	Unsharp mask 1 CPU	s	3.9-7.8
A_2	Unsharp mask 2 OCL	s	1.7-7.5
A_3	Save PNG	s	14-22
A_4	Save JPEG	s	1.5-2.2

Video Editing test

The Video Editing test use cases capture some common uses of video editing applications.

Implementation

The Video Editing test uses parts from PCMark 8 Video Editing and Media To Go tests.

Windows Media Foundation is used with its built-in codecs to transcode video. Hardware acceleration is allowed to be used if the system supports it and has the necessary Media Foundation setup done.

The Video Editing test uses FFmpeg on the sharpening and deshaking parts. The test uses pre-built FFmpeg binaries.

The Video editing test supports OpenCL. The benchmark application selects a preferred OpenCL device to use.

Part 1: on the go

Stage 1: Fast downscaling

- Code path: x86/x64
- Uses Media Foundation Fast transcode feature to transcode video files to a format suitable for mobile use
- Code path: x86/x64 and whatever is the implementation with Media Foundation H.264 codecs installed on the system
- Similar to Video to go test in PCMark 8

Part 2: Sharpening

- Sharpens the 1080p H.264 video
- Uses publicly available executable FFmpeg.exe
- Command line: FFmpeg.exe -y -v 40 -i <input file> -vf scale=w=1920:h=1080:flags=bicubic,unsharp=opencl=%OCL%:lx=7:ly=7:la=0.56:cx=7:cy=7:ca=0.28 -strict -2 <output file>
- Stage 2 - CPU:
  - Run always
  - Code path: x86/x64
- Stage 2 - OCL:
  - Condition: OpenCL device available
  - Code path: OpenCL
  - If the OpenCL of the Stage 2 test takes longer than the CPU version, the CPU result is used instead

Part 3: Deshaking

- Uses publicly available executable FFmpeg.exe
- Video deshaked
- Command line: FFmpeg.exe -y -v 40 -i <input file> -vf deshake=opencl=%OCL%:search=1:blocksize=16,crop=in_w-384:in_h-216,scale=w=1920:h=1080 -strict -2 <output file>
- Stage 3 - CPU:
  - Run always
  - Code path: x86/x64
- Stage 3 - OpenCL:
  - Condition: OpenCL device available
  - Code path: OpenCL
  - If the OpenCL test takes longer than the CPU test, the CPU run time is used instead

Workloads

The Video Editing test simulates editing videos in an video editing program. The workloads performs the following tasks:

1. Fast downscaling, common for example in use with mobile devices
2. Sharpening the video
3. Deshaking filtering

The workloads measure the frames produced per second in the video editing program.

$$On\ the\ go = \frac{M_1}{M_2}$$

Where:

$$M_1 = dbg\_pcm10\_video\_go\_frames$$

$$M_2 = dbg\_pcm10\_video\_go\_time$$

$$Sharpening\ CPU = \frac{M_3}{M_4}$$

Where:

$$M_3 = dbg\_pcm10\_video\_downscale\_frames$$

$$M_4 = dbg\_pcm10\_video\_downscale\_time\_cpu$$

$$Sharpening\ OCL = \frac{M_5}{Min(M_6, M_7)}$$

Where:

$$M_5 = dbg\_pcm10\_video\_downscale\_frames$$

$$M_6 = dbg\_pcm10\_video\_downscale\_time\_ocl$$

$$M_7 = dbg\_pcm10\_video\_downscale\_time\_cpu$$

$$Deshaking\ CPU = \frac{M_8}{M_9}$$

Where:

$$M_8 = dbg\_pcm10\_video\_deshake\_frames$$

$$M_9 = dbg\_pcm10\_video\_deshake\_time\_cpu$$

$$Deshaking\ OCL = \frac{M_{10}}{Min(M_{11}, M_{12})}$$

Where:

$$M_{10} = dbg\_pcm10\_video\_deshake\_frames$$

$$M_{11} = dbg\_pcm10\_video\_deshake\_time\_ocl$$

$$M_{12} = dbg\_pcm10\_video\_deshake\_time\_cpu$$

Scoring

The Photo Editing test score formula uses a geomean of the workloads to calculate the overall score.

$$Video\ Editing\ score = K * geomean(R_1, R_2, R_3)$$

Where:

$$K = scoring\ coefficient = \ 93$$

$$R_2 = \ geomean(A_1, A_2)$$

$$R_3 = \ geomean(A_3, A_4)$$

And where:

Result	Definition	Unit	Typical range
R_1	On the go	FPS	17-51
A_1	Sharpening CPU	FPS	31-47
A_2	Sharpening OCL	FPS	67-154
A_3	Deshaking CPU	FPS	13-17
A_4	Deshaking OCL	FPS	49-83

Rendering and Visualization

The test models the use of hobbyist and professional 3D design, modelling and visualisation applications.

The test covers two scenarios:

1. Visualization of a 3D model
2. Calculating a simulation

Implementation

The tests use a modified engine from 3DMark Sling Shot running custom content in an OpenGL 4.3 code path.

The ray tracing test uses POV-Ray build created by Futuremark. The modifications are:

- The width and height for the image produced by the POV-Ray benchmark has been changed from 512 × 512 to 256 × 256.
- The registry entry is changed from POV-Ray to POV-Ray-Futuremark
- The editor is not loaded
- Removed a warning about "ambient" being deprecated from the main window.

The workload for the ray tracing test is the built in benchmark scene in POV-Ray, with the output image size 256 × 256. The score is calculated as the total time it took to run the POV-Ray benchmark.

Scoring

$$Rendering\ and\ Visualization\ score = K * geomean\left(R_1, \frac{1}{R_2}\right)$$

Where:

$$K = scoring\ coefficient = 3530$$

Result	Definition	Unit	Typical range
R_1	Graphics	FPS	13-245
R_2	Ray tracing	s	46-110

Gaming test group

Gaming test group uses a modified version of the Fire Strike test in 3DMark:

1. Fire Strike Graphics test 1
2. Fire Strike Graphics test 2
3. Fire Strike Physics test
4. Fire Strike Combined test

> ⚠ The PCMark 10 gaming test runs in a window rather than full screen, and it always runs on a single GPU even if multiple GPUs are available in this system. For these reasons, you should not compare Gaming test scores from PCMark 10 with Fire Strike scores from 3DMark.

Fire Strike

Fire Strike is a DirectX 11 benchmark for high-performance gaming PCs. Fire Strike includes two graphics tests, a physics test and a combined test that stresses both the CPU and GPU.

Graphics test 1

3DMark Fire Strike Graphics test 1 focuses on geometry and illumination. Particles are drawn at half resolution and dynamic particle illumination is disabled. There are 100 shadow casting spot lights and 140 non-shadow casting point lights in the scene. Compute shaders are used for particle simulations and post processing. Pixel processing is lower than in Graphics test 2 as there is no depth of field effect.

Processing performed in an average frame

	Vertices	Tessellation patches	Triangles	Pixels[6]	Compute shader invocations
Fire Strike	3.9 million	500,000	5.1 million	80 million	1.5 million

Graphics test 2

3DMark Fire Strike Graphics test 2 focuses on particles and GPU simulations. Particles are drawn at full resolution and dynamic particle illumination is enabled. There are two smoke fields simulated on GPU. Six shadow casting spot lights and 65 non-shadow casting point lights are present. Compute shaders are used for particle and fluid simulations and for post processing steps. Post processing includes a depth of field effect.

Processing performed in an average frame

	Vertices	Tessellation patches	Triangles	Pixels[2]	Compute shader invocations
Fire Strike	2.6 million	240,000	5.8 million	170 million	8.1 million

---

[6] This figure is the average number of pixels processed per frame before the image is scaled to fit the native resolution of the device being tested. If the device's display resolution is greater than the test's rendering resolution, the actual number of pixels processed per frame will be even greater.

Physics test

3DMark Fire Strike Physics test benchmarks the hardware's ability to run gameplay physics simulations on the CPU. The GPU load is kept as low as possible to ensure that only the CPU is stressed. The Bullet Open Source Physics Library is used as the physics library for the test.

The test has 32 simulated worlds. One thread per available CPU core is used to run simulations. All physics are computed on CPU with soft body vertex data updated to GPU each frame.

Combined test

3DMark Fire Strike Combined test stresses both the GPU and CPU simultaneously. The GPU load combines elements from Graphics test 1 and 2 using tessellation, volumetric illumination, fluid simulation, particle simulation, FFT based bloom and depth of field.

The CPU load comes from the rigid body physics of the breaking statues in the background. There are 32 simulation worlds running in separate threads each containing one statue decomposing into 113 parts. Additionally there are 16 invisible rigid bodies in each world except the one closest to camera to push the decomposed elements apart. The simulations run on one thread per available CPU core.

The 3DMark Fire Strike Combined test uses the Bullet Open Source Physics Library.

Processing performed in an average frame

	Vertices	Tessellation patches	Triangles	Pixels[7]	Compute shader invocations
Fire Strike	7.5 million	530,000	7.9 million	150 million	110 million

Overall Fire Strike score

The 3DMark Fire Strike score formula uses a weighted harmonic mean to calculate the overall score from the Graphics, Physics, and Combined scores.

---

[7] This figure is the average number of pixels processed per frame before the image is scaled to fit the native resolution of the device being tested. If the device's display resolution is greater than the test's rendering resolution, the actual number of pixels processed per frame will be even greater.

$$\text{Fire Strike score} = K * \frac{Wgraphics + Wphysics + Wcombined}{\dfrac{Wgraphics}{Sgraphics} + \dfrac{Wphysics}{Sphysics} + \dfrac{Wcombined}{Scombined}}$$

Where:

$K = 0.834 (\text{scales the scores to } 5{,}000 \text{ on the high} - \text{reference PC})$

$Wgraphics$	=	The Graphics score weight, equal to 0.75
$Wphysics$	=	The Physics score weight, equal to 0.15
$Wcombined$	=	The Combined score weight, equal to 0.10
$Sgraphics$	=	Graphics score
$Sphysics$	=	Physics score
$Scombined$	=	Combined score

For a balanced system, the weights reflect the ratio of the effects of GPU and CPU performance on the overall score. Balanced in this sense means the Graphics, Physics and Combined scores are roughly the same magnitude.

For a system where either the Graphics or Physics score is substantially higher than the other, the harmonic mean rewards boosting the lower score. This reflects the reality of the user experience. For example, doubling the CPU speed in a system with an entry-level graphics card doesn't help much in games since the system is already limited by the GPU. Likewise for a system with a high-end graphics card paired with an underpowered CPU.

Graphics score

Each Graphics test produces a raw performance result in frames per second (FPS). We take a harmonic mean of these raw results and multiply it by a scaling constant to reach a Graphics score ($Sgraphics$) as follows:

$$Sgraphics = 230 \times \frac{2}{\dfrac{1}{Fgt1} + \dfrac{1}{Fgt2}}$$

Where:

$Fgt1$	=	The average FPS result from Graphics test 1
$Fgt1$	=	The average FPS result from Graphics test 2

The scaling constant is used to bring the score in line with traditional 3DMark score levels.

Physics score

$$Sphysics = 315 \times Fphysics$$

Where:

$Fphysics$ = The average FPS result from the Physics Test

The scaling constant is used to bring the score in line with traditional 3DMark score levels.

Combined score

$$Scombined = 215 \times Fcombined$$

Where:

$Fcombined$ = The average FPS result from the Combined Test

The scaling constant is used to bring the score in line with traditional 3DMark score levels.

Find more details in 3DMark Technical Guide.

Benchmark Scores

Result screen

The Result screen is divided into sections.

1. Benchmark score
2. Result details
3. System information
4. Monitoring

Benchmark score

PCMark 10 benchmarks produce an overall score. You can use this score to compare the performance of different systems. The higher the score, the better the performance.
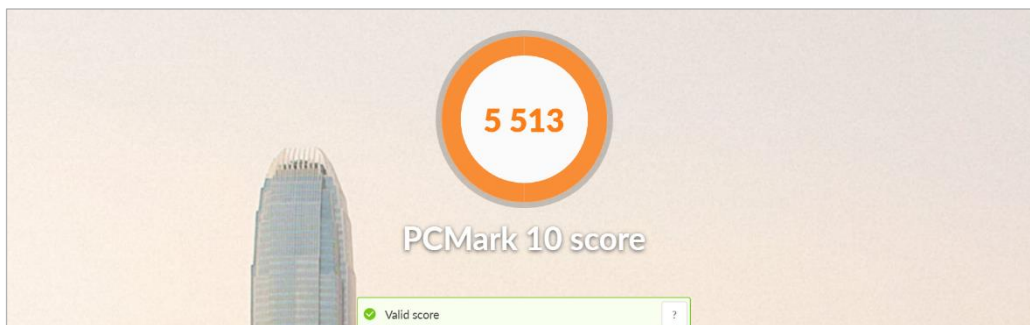
The ring graphic is a visual indication of the benchmark score as a percentage of the reference machine. The PCMark 10 benchmark tests were designed for the reference machine, which can score 5000 in these tests.

The score validation box is either green, showing 'Valid score' if the result passes our checks; or red, showing details of any errors or problems with the run. You can click on the [?] icon in both cases for more information.

The scores for the PCMark 10 benchmark tests are explained earlier in the PCMark 10, PCMark 10 Extended and PCMark 10 Express chapters.

> ⚠ Scores from PCMark 10, PCMark 10 Extended and PCMark 10 Express should not be compared with each other. They are separate tests. Each one produces its own score.

Result details

This section provides more details of your result. The overall score appears in the top left with the name and version number of the benchmark.

5 513 IN PCMark 10 V1.0

Detailed scores ⬤

| Essentials | 8 231 | Productivity | 7 629 | Digital Content Creation | 7 241 |

In the table, you'll find the scores for each test group. You can expand the 'Detailed score' to get the scores for the workloads and the performance for each task.

5 513 IN PCMark 10 V1.0

Detailed scores 🟠

Essentials	8 231	Productivity	7 629	Digital Content Creation	7 241
› App Start-up Score	9 593	› Spreadsheets Score	9 594	› Photo Editing Score	7 844
› Video Conferencing Score	7 737	⌄ Writing Score	6 068	› Rendering and Visualization Score	9 763
⌄ Web Browsing Score	7 516	Load document	1.396 s	⌄ Video Editing Score	4 958
Social media page load	0.143 s	Save document	1.200 s	On the go	47.53 fps
Social media feed update	0.153 s	Add pictures to document	0.604 s	Downscaling OpenCL	212.00 fps
Shop view image	60.00 fps	Copy and paste	0.120 s	Downscaling CPU	41.00 fps
Shop load 3D object	1.729 s	Cut and paste	0.348 s	Deshaking CPU	15.00 fps
Shop animate 3D object	300.00 fps			Deshaking OpenCL	78.00 fps
Map infographics update	0.140 s				
Map zooming	0.044 s				
Video 1080p H.264	30.00 fps				
Video 2160p H.264	30.00 fps				
Video 1080p VP9	30.00 fps				
Video 2160p VP9	30.00 fps				

System information

This section of the result page shows information about the hardware components in your system, a time stamp for the result, and the SystemInfo and PCMark 10 application version numbers for the benchmark run.

System information

System details ⬤

GPU	NVIDIA GeForce GTX 1080	CPU	AMD Ryzen 7 1800X	Time	2017-05-23 12:29 +03:00
SystemInfo	v5.1.620	Application	v1.0.1198 64		

In the PCMark 10 Professional Edition, you can expand the 'System details' to see the additional hardware details. The "Additional Outputs' lists the devices that were used by the APIs for the benchmark run. These details can be used in interpreting the results.

System information

System details ●

🖵 Graphics adapter

GPU	NVIDIA GeForce GTX 1080
Memory	8192MB GDDR5X
Code name	GP104
Manufacturer	NVIDIA / NVIDIA
Manufacturing process	16 nm
Driver version	22.21.13.8205
Core Clock	1607 MHz (1607 MHz)
Boost Clock	1734 MHz (1734 MHz)
Memory clock	1251 MHz (1251 MHz)
Display 1	\\.\DISPLAY1 (1920 × 1080)

▣ Processor

CPU	AMD Ryzen 7 1800X
Code name	Summit Ridge
Clock frequency	-1 MHz
Cores	8 (16)
Package	Socket AM4 (1331)
Instructions	MMX EXTENDED_MMX SSE SSE2 SSE3 SSSE3 SSE41 SSE42 SSE4A X86_64 NX VMX
Manufacturing process	14 nm
Core VID	1.481250 V
Max Cache Level	3
Hyper Threading	Yes
Virtual Technology	Yes

⬛ General

Motherboard	ASUSTeK COMPUTER INC. PRIME X370-PRO
North bridge	AMD X370
Total memory	16384 MB
Module 1	8192 MB DDR4_SDRAM @ 2394 MHz DDR
Module 2	8192 MB DDR4_SDRAM @ 2394 MHz DDR
BIOS	American Megatrends Inc. 04/06/2017
Operating system	Windows 10 64-bit
Total storage	476.94 GB
Drive 1	Samsung SSD 850 EVO 500GB 476.94 GB
Time	2017-05-23 12:29 +03:00
HPET	Not used
Application	v1.0.1198 64
SystemInfo	v5.1.620
Power plan	Balanced
Battery	

Additional Outputs

Test	Device used	Type
Video Conferencing	NVIDIA H.264 Encoder MFT	Video Encoder
Video Conferencing	GeForce GTX 1080	OpenCL
Spreadsheets	GeForce GTX 1080	OpenCL
Photo Editing	GeForce GTX 1080	OpenCL
Video Editing	GeForce GTX 1080	OpenCL

Monitoring

In PCMark 10 Professional Edition, the benchmark result comes with hardware monitoring charts. Use these charts to see how various performance and hardware metrics changed during the test.

In the default view, the chart will automatically cycle through the different metrics. You can click on a legend bar to see a metric without waiting.

Click the 'Monitoring details' on the right to expand the view and see all the charts at once.

Move your mouse pointer over the chart to see the values for each metric at that point in time. This helps you quantify any peaks and dips in performance.

At the bottom right, you'll find buttons to save your result, giving it a name and description, and load results. Click on the 'Compare' button to compare your result in the application or 'View online' to compare your result online with others at 3dmark.com. These options are available in the Professional Edition only.

Temperature

The chart shows how CPU temperature and GPU temperature changed during the benchmark run.

Frequency

The chart shows how CPU frequency, GPU core clock and GPU memory clock changed during the benchmark run.

Power Consumption

The chart shows how CPU power consumption and GPU power consumption changed during the benchmark run.

Load

The chart shows how GPU load changed during the benchmark run.

Result export

Exclusive to the PCMark 10 Professional Edition is the result exporting feature. The results can be exported as PDF and XML.

The PDF result report includes the hardware monitoring graphs to provide a full view of the benchmark run making it easier to store and share test results.

The PDF result report can be customized with your own logo. Go to the Options screen to select your logo file.

Compare results

The Compare screen is divided into sections.

1. Score comparison
2. System information
3. Monitoring

Score comparison

With PCMark 10, you can now compare two results side by side in the application. Click the 'Compare' button on the result screen to select two results for comparison. This feature is available in the PCMark 10 Professional Edition only.
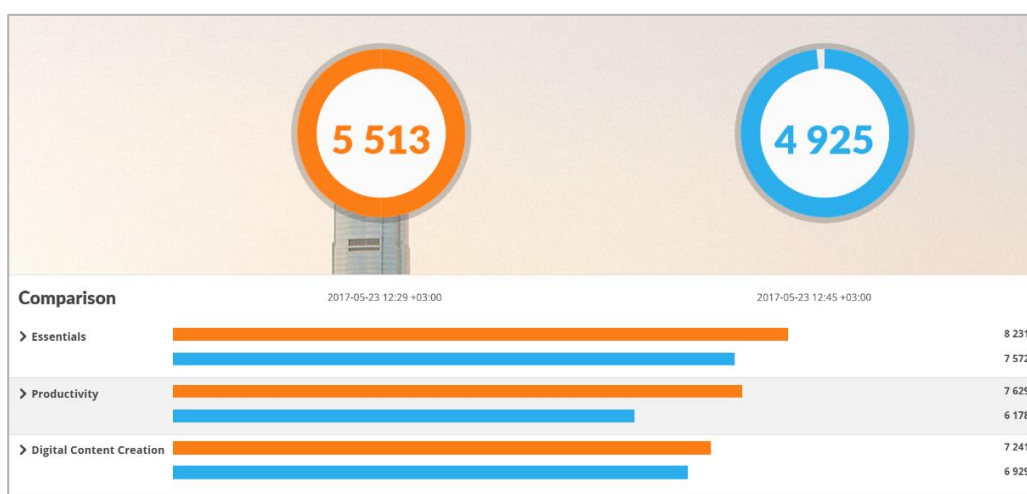
The bar charts compares the scores for each test group. Expand each test group to compare the workloads. The bars represent the scores for each test group. The bars in the chart are illustrated in proportion to the highest score of all the test groups.

Click on the arrows in front of the test groups to expand additional details.

System information

This section of the Comparison page shows information about the hardware components of the compared system, SystemInfo and the PCMark 10 application version numbers used for the benchmark runs.

Expand the 'System details' to get a detailed view of the hardware components in your system, a time stamp for the result, and the SystemInfo and PCMark 10 application version numbers for the benchmark run.

| System information		System details ⬤
🖵 Graphics adapter		
Boost Clock	1734 Mhz (1734 Mhz)	1734 Mhz (1734 Mhz)
Core Clock	1607 Mhz (1607 Mhz)	1607 Mhz (1607 Mhz)
Code name	GP104	GP104
Driver version	22.21.13.8205	22.21.13.8205
Manufacturing process	16 nm	16 nm
Memory	8192MB GDDR5X	8192MB GDDR5X
Memory Clock	1251 Mhz (1251 Mhz)	1251 Mhz (1251 Mhz)
Name	NVIDIA GeForce GTX 1080	NVIDIA GeForce GTX 1080
Manufacturer	NVIDIA / NVIDIA	NVIDIA / NVIDIA
Boost Clock		1734 Mhz (1734 Mhz)
Core Clock		1607 Mhz (1607 Mhz)
Code name		GP104
Driver version		22.21.13.8205
Manufacturing process		16 nm
Memory		8192MB GDDR5X
Memory Clock		1251 Mhz (1251 Mhz)
Name		NVIDIA GeForce GTX 1080
Manufacturer		NVIDIA / NVIDIA
▣ Processor		
Cores	8 (16)	6 (12)
Hyper Threading	Yes	Yes
Instructions	MMX EXTENDED_MMX SSE SSE2 SSE3 SSSE3 SSE41 SSE42 SSE4A X86_64 NX VMX	MMX SSE SSE2 SSE3 SSSE3 SSE41 SSE42 X86_64 NX VMX
Manufacturing process	14 nm	22 nm
Max Cache Level	3	3
Name	AMD Ryzen 7 1800X	Intel Core i7 5930K
Code name	Summit Ridge	Haswell-E/EP
Package	Socket AM4 (1331)	Socket 2011 LGA
Clock frequency	-1 MHz	3500 MHz
Virtual Technology	Yes	Yes
Core VID	1.481250 V	0.751709 V
⬛ General		
Time	2017-05-23 12:29 +03:00	2017-05-23 12:45 +03:00
Motherboard	ASUSTeK COMPUTER INC. PRIME X370-PRO	ASUSTeK COMPUTER INC. X99-DELUXE
BIOS	American Megatrends Inc. 04/06/2017	American Megatrends Inc. 04/08/2016
Operating system	Windows 10 Enterprise 64-bit (10.0.15063)	Windows 10 Enterprise 64-bit (10.0.15063)
HPET	Not used	Not used
Application	v1.0.1198 64	v1.0.1198 64
SystemInfo	v5.1.620	v5.1.620
Power plan	Balanced	Balanced
Battery		
North bridge	AMD X370	Intel X99
Total storage	466 GB	477 GB
Drive(s)	Samsung SSD 850 EVO 500GB 466 GB	Crucial_CT512MX100SSD1 477 GB
Memory Modules	8192 MB DDR4_SDRAM @ 2400 MHz 8192 MB UNKNOWN @ 0 MHz	4096 MB DDR4_SDRAM @ 2133 MHz 4096 MB DDR4_SDRAM @ 2133 MHz 4096 MB UNKNOWN @ 0 MHz 4096 MB UNKNOWN @ 0 MHz
Total memory	16384 MB	16384 MB

Monitoring

The Compare page comes with hardware monitoring charts that you can use to compare the performance and hardware metrics of two benchmark results in parallel.

In the default view, the chart will automatically cycle through the different metrics. You can click on a legend bar to see a metric without waiting.

Click the 'Monitoring details' on the right to expand the view and see all the charts at once.

Move your mouse pointer over the chart to see the values for each metric at that point in time. This helps you quantify any peaks and dips in performance.
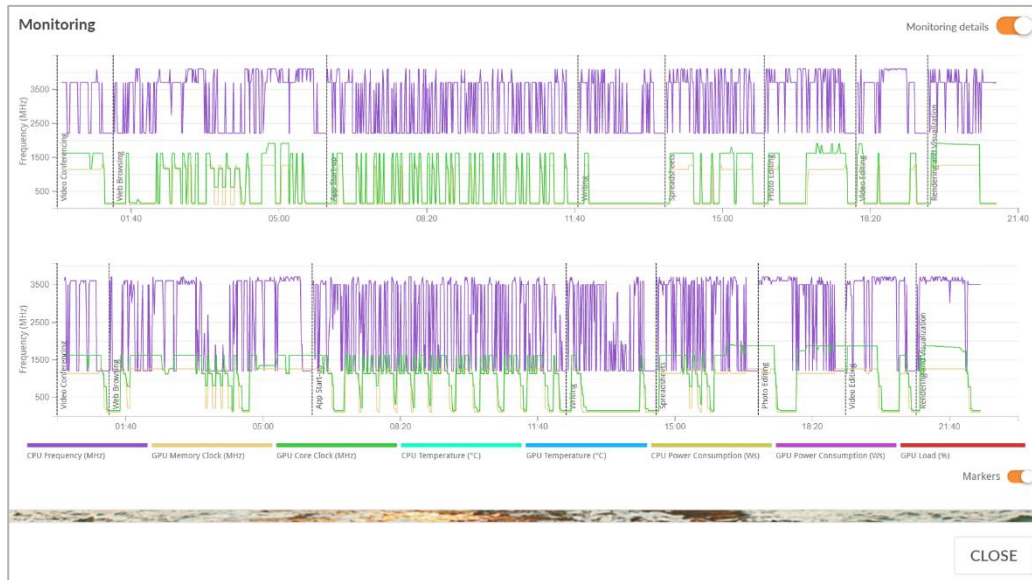
The 'Close' button returns the Result page.

How to report scores from PCMark 10

Please follow these guidelines when including PCMark 10 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 score. Scores from different tests are not comparable. Do not use PCMark as a unit of measurement.

✓   "Tablet scores 2,000 in PCMark 10 Express 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 10 scores in marketing material

You must have a commercial license to use PCMark 10 scores in marketing material. A commercial license is granted with the purchase of PCMark 10 Professional Edition or through our site licensing program.

On the first mention of PCMark 10 in marketing text, such as an advertisement or product brochure, please write "PCMark 10 benchmark" in order to protect our trademark. For example:

"We recommend the PCMark® 10 benchmark from Futuremark®."

Please include our legal text in your small print.

PCMark® is a registered trademark of Futuremark Corporation.

Release notes

PCMark 10 v1.0.1493 – April 11, 2018

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

Improved

- SystemInfo module updated to 5.6 for improved compatibility with the latest hardware.
- The system information shown on the result screen now includes DPI scaling settings for each connected display.
- Improved consistency in how system information is shown in the UI and PDF reports.

PCMark 10 v1.0.1457 – January 31, 2018

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

Fixed

- Fixed a further issue that could cause Chromium to fail to start in the App Start-up and Web Browsing tests.

PCMark 10 v1.0.1453 – January 30, 2018

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

Improved

- SystemInfo module updated to 5.4 for improved compatibility with the latest hardware.

Fixed

- Fixed an issue with the Rendering and Visualization test being unable to install POV-Ray.
- Fixed an issue where Chromium could fail to start in the App Start-up and the Web Browsing tests.

Compatibility

- Updated the .NET installer to .NET 4.5.2.

PCMark 10 v1.0.1413 – December 18, 2017

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

Improved

- Improved logging from ImageMagick in the Photo Editing test.

Fixed

- Fixed an issue that could cause PCMark 10 to hang on the splash screen.
- Fixed an issue with the Rendering and Visualization test being unable to install POV-Ray.
- Fixed an issue with the Web Browsing test failing on some devices due to the sound codecs not loading.

PCMark 10 v1.0.1403 – November 13, 2017

Improved

- SystemInfo module updated to 5.3.629 for improved compatibility with the latest hardware.

Fixed

- Fixed an issue with the Web Browsing video workload not starting in some cases.
- Fixed an issue with the Web Browsing workload not starting when running on a proxy server.
- Improved logging for the App Start-up, Spreadsheets, Writing, and Web Browsing workloads.

Professional Edition only

- You can now customize the PDF result report with your own logo.
- Added hardware monitoring graphs to the PDF result report.
- Subscores from PCMark 10 Extended benchmark runs are now included in PDF and XML result reports.
- Fixed the "--clean-temporary-files" command line option.
- Added a new command line setting "tempdir" for overriding the default location for the workloads' temporary files.

PCMark 10 v1.0.1275 – June 28, 2017

Fixed

- Fixed localization: flipped the localization for "Valid Score" and "Invalid Score" in Simplified Chinese.
- Fixed the Verify button on the Options page in the standalone version to validate installed files.

PCMark 10 v1.0.1271 – June 22, 2017

This is a major update that unlocks the features in the Basic Edition and Advanced Edition. It is the first publicly available version of PCMark 10 that includes all editions. Benchmark scores are not affected by this update.

PCMark 10 v1.0.1238 – June 5, 2017

- Public release of PCMark 10 Professional Edition.

PCMark 10 v1.0.1198 – May 24, 2017

- Pre-release preview version for press publications.

Third party software

This is a list of third party software and applications used in PCMark 10 benchmark tests.

LibreOffice v5.2.4.2

- Built by Futuremark from the open-source code at: http://libreoffice.com/
- Modified only to use different GUIDs for COM interfaces.

ImageMagick v6.9.8.0

- By ImageMagick Studio LLC
- Built by Futuremark from the source code at http://www.imagemagick.org/download/windows/

OpenCV v3.1.0

- Built by Futuremark from the source code at https://github.com/Itseez/opencv/

FFmpeg v3.0.1

- Pre-built binary available at: https://ffmpeg.zeranoe.com/builds/

GIMP v2.8.14

- Pre-built binary available at: https://www.gimp.org/downloads/
- Specifically: https://download.gimp.org/mirror/pub/gimp/v2.8/
- Custom install, no extra languages, 64-bit left out.

Firefox v53 Beta

- Version v53.0b1
- Portable version http://portableapps.com/apps/internet/firefox_portable
- Some parameters were changed to prevent automatic updates and plugin installation.

Chromium v55

- Version v55.0.2883.87
- Built by Futuremark from the source code at http://www.chromium.org/Home

AutoIt3 v3.3.14.2

- Used as is. Downloaded as a self-extracting zip from https://www.autoitscript.com/site/autoit/downloads/

POV-Ray v.3.7.1 Beta 5

- Commit `ea3d549a0c27c0dfb5c51e9fcd980866cfaf654b`
- Built by Futuremark from the source code at https://github.com/POV-Ray/povray/commit/ea3d549a0c27c0dfb5c51e9fcd980866cfaf654b.
- The changes made by Futuremark will be available publicly as patch files.
- The default POV-Ray benchmark scene and settings are used. They can be viewed in the installation folder `scenes\advanced\benchmark` or found at http://www.povray.org/download/benchmark.php

Reference systems

Score-scaling reference systems

These systems were used to set the score-scaling coefficients:

Essentials reference PC

This system scores 5000 in each test in the Essentials group

- HP Pavilion 14-al092no
- CPU: Intel(R) Pentium(R) 4405U @ 2.10 GHz
- GPU: Intel(R) HD Graphics 510
- 4 GB DDR4 RAM 2133 MHz
- 128 GB M.2 SSD

Productivity reference PC

This system scores 5000 in each test in the Productivity group.

- Lenovo IdeaPad 710s Signature Edition
- CPU: Intel(R) Core(TM) i5-6200U CPU @ 2.40GHz
- GPU: Intel(R) HD Graphics 520
- 8 GB DDR3 RAM 1866 MHz
- SSD: 256 GB M.2 NVMe

Digital Content Creation reference PC

This system scores 5000 in each test in the Digital Content Creation test group, in the Gaming test group, and Overall scores.

- CPU: Intel(R) Core(TM) i5-7600K CPU @ 3.80GHz
- GPU: NVIDIA GeForce GTX 1050 (2 GB)
- SSD: Samsung SSD 850 EVO 500 GB
- 16 GB DDR4 RAM 2667 MHz

Metric range reference systems

These systems were used for evaluating the typical range of each test metric:

Desktop 1 (Digital Content Creation reference PC)

- CPU: Intel(R) Core(TM) i5-7600K CPU @ 3.80GHz
- GPU: NVIDIA GeForce GTX 1050 (2 GB)
- SSD: Samsung SSD 850 EVO 500 GB
- 16 GB DDR4 RAM 2667 MHz

Dell OptiPlex 3040 ("lower mid-range desktop PC")

- CPU: Intel(R) Core(TM) i3-6100 CPU @ 3.70GHz
- GPU: Intel(R) HD Graphics 530
- HDD: TOSHIBA DT01ACA050
- 4 GB DDR3 RAM

About Futuremark, UL company

Futuremark creates benchmarks that enable people to measure, understand and manage computer hardware performance. Our talented team creates the industry's most authoritative and widely used performance tests for desktop computers, notebooks, tablets, smartphones and VR systems.

We work in cooperation with many of the world's leading technology companies to develop industry standard benchmarks that are relevant, accurate, and impartial. As a result, our benchmarks are widely used by the world's leading press publications and review sites.

Futuremark maintains the world's most comprehensive hardware performance database, using results submitted by millions of users to help consumers make better purchasing decisions.

Our headquarters are in Finland just outside the capital Helsinki. We also have sales and field application engineering support in Silicon Valley and Taiwan.

Futuremark became a part of UL in 2014. UL is a global safety science company with more than a century of expertise and innovation in the fields of product safety testing, inspection and verification services. With more than 10,000 professionals in 40 countries, UL is dedicated to creating safe working and living environments for all.

UL partners with businesses, manufacturers, trade associations, regulators, and governments to play a key role in the development and harmonization of national and international standards. For more information about certification, testing, inspection, advisory and education services, visit http://www.UL.com.

Please don't hesitate to contact us if you have a question about PCMark 10.

Press   press@futuremark.com
Business   sales@futuremark.com
Support   http://www.futuremark.com/support