PCMARK®10

Technical Guide

Updated February 11, 2021

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 performance benchmarks to get scores that you can use to compare systems. Or see how the battery life changes with common real-world scenarios.

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, Applications, and Custom run options for exploring other aspects of performance if needed. You can also see how the battery life changes with common scenarios.

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

PCMark 10 includes new performance benchmarks and a new approach to battery life testing. A dedicated Storage benchmark that improves on the PCMark 8 test is in development and will be released as an update.

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.

PCMARK 8	PCMARK 10	IMPROVEMENTS IN PCMARK 10
-	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.
Casual Gaming	-	This test was dropped from PCMark 10 since DirectX 9 is less relevant in in today's games.
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.

Battery Life testing

PCMark 10 introduces a new approach—the PCMark 10 Battery Life Profile. Instead of a single number, the PCMark 10 Battery Life Profile provides a broader view of battery life across a range of common scenarios, such as office work, video, and gaming.

In PCMark 8, battery life tests are based on set combinations of workloads. It is not possible to isolate battery life for specific tasks.

PCMARK 8	PCMARK 10
Test battery life with Home, Creative, and Work scenarios in Conventional or Accelerated mode.	Battery life profile with Modern Office, Applications, Video, Gaming and Idle scenarios.

In PCMark 8, the battery life tests run until the battery falls below 20%. The reported battery life is an estimate of the 95% duty cycle (from 100% charged to 5%) extrapolated from the battery life measured during the test.

PCMark 10 battery life tests run until the PC goes into hibernation or shuts down. The reported battery life is the battery life measured during the test.

Storage testing

PCMark 10 Storage benchmarks use a trace-based approach. Unlike the Storage test in PCMark 8, which plays back traces from a single sandbox file, PCMark 10 Storage benchmarks use a file-based solution, where the benchmark creates files corresponding to the original ones.

This approach lets you measure the performance of the whole storage stack from the application perspective. The trace playback system supports multithreaded I/O.

	PCMARK 8	PCMARK 10
NUMBER OF BENCHMARKS	1	3
ADDITIONAL TESTS	Consistency test, Adaptivity test	Drive Performance Consistency Test
RUN TIME FOR SSD	1 – 3 hours	Full 45-90 minutes Quick 10-20 minutes Data 15 minutes Consistency 10-20 hours
TARGET DEVICES	HDD, later SATA SSD, (NVMe)	Full – SATA SSD, NVMe, Optane Quick - HDD, SATA, SSD, NVMe Data – USB, SATA, Thunderbolt
DATA WRITTEN	-	Full - 204 GB Quick – 23 GB Data – 15 GB
TEST FOOTPRINT (SPACE USED / REQUIRED)	20 GB	Full – 65 GB Quick – 10 GB Data – 6 GB

	PCMARK 8	PCMARK 10
THREADING / CPU MULTI CORE SUPPORT	Single threaded, may run into CPU bottleneck with fast drives	Multi-threaded to support up to 5GB/s bandwidth
CONSISTENCY TEST	Command line run only. No visualization of data. “Sandbox” based. Empty drives only.	Integrated into the UI. Export to Excel. File based. Can be run on a system drive or a drive with user data.
USB AND THUNDERBOLT DRIVE TESTING	The system drive test can run on removable drives if when formatted with NTFS.	Specifically designed for data drives. Supports NTFS and FAT32.

PCMARK 10 EDITIONS

	BASIC EDITION	ADVANCED EDITION	PROFESSIONAL EDITION
PCMark 10 benchmark	●	●	●
PCMark 10 Express	×	●	●
PCMark 10 Extended	×	●	●
PCMark 10 Applications	×	×	●
PCMark 10 Battery Life	×	×	●
PCMark 10 Storage Benchmarks	×	×	●
Compare results in-app	×	●	●
Hardware monitoring	×	●	●
Custom run settings	×	●	●
Save results offline	×	●	●
Private, offline results option	×	×	●
Command line automation	×	×	●
Export result as PDF	×	×	●
Export result as XML	×	×	●
Licensed for commercial use	×	×	●
Compatible with Testdriver®	×	×	●
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

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

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.

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.
PCMARK 10 APPLICATIONS	A benchmark for testing the performance of office PCs using Microsoft Office applications.

Each benchmark produces a score that you can use to compare systems. A higher score 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.

Choosing a suitable battery life scenario

PCMark 10 has a range of battery life scenarios that reflect common, real-world tasks.

MODERN OFFICE	Measure battery life for common office tasks: writing, web browsing, and video conferencing.

APPLICATIONS	Measure battery life for work tasks using Microsoft Office applications.
VIDEO	Measure battery life for video playback.
GAMING	Measure battery life with a constant, heavy gaming load to find the lower limit of the battery life profile.
IDLE	Measure battery life for inactive times between tasks to produce the upper limit of the battery life profile.

Choosing a suitable storage benchmark

PCMark 10 includes four storage benchmarks for testing and comparing the performance of the latest SSDs and other storage devices.

FULL SYSTEM DRIVE BENCHMARK	A wide-ranging test for modern drives.
QUICK SYSTEM DRIVE BENCHMARK	A shorter test with lighter workloads for smaller drives.
DATA DRIVE BENCHMARK	A test for data drives and external storage devices.
STORAGE PERFORMANCE CONSISTENCY TEST	An extremely demanding test for expert users.

HOW TO TEST 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, 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 TEST BATTERY LIFE

PC setup and configuration

To produce comparable and reliable results, start with the PC's factory settings and a fully charged battery.

1. If the device is new, or the battery hasn't been discharged for a while, follow the manufacturer's advice to calibrate and condition the battery.
2. Set the following settings:
    a. Set DPI scaling to 100%
    b. Disable WiFi / Bluetooth / Cellular
    c. Disable Screen Saver and Monitor Timeout
    d. Disable search indexing and automatic updating
    e. Under Sign-in options, Set Require sign-in to Never
    f. Set the screen brightness level to 110 cd/m2[2]
3. Unplug peripherals that consume power, such as external keyboards and mice, USB memory sticks, etc.

Screen brightness settings

Screen brightness can have a significant effect on battery life. To produce comparable results, you should calibrate every device you test to the same screen brightness. In practice, this is difficult without specialist equipment.

PCMark 10 provides a pure white calibration screen and a video to help you calibrate screen brightness. You'll find them in the PCMark 10 installation folder, which by default is found here:

C:\Program Files\UL\PCMark 10\Battery Life Calibration Tools

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 another 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.

[2] Luminance is occasionally expressed in Nits. Nit is a non-SI name used for units of luminance. A Nit is equivalent to the SI unit, i.e. 1 nit = 1 cd/m2.

Power plan settings

To ensure fair comparison of results, you should use the same power plan settings on every system you test.

For your convenience, PCMark 10 includes a custom Power Plan configuration file with our recommended settings. You'll find it here:

C:\Program Files\UL\PCMark 10\Battery Life Calibration Tools

Import power plan using PowerCFG (recommended)

1. From Start, search for Command Prompt.
2. Right-click and select Run as administrator.
3. Type the following command then press Enter. (Change the path if you have installed PCMark 10 to a non-default location)
   a. powercfg -import "C:\Program Files\UL\PCMark 10\Battery Life Calibration Tools\PCMark10BatteryProfile.pow"
4. Type the following command to list the power schemes:
   a. powercfg -list
5. Copy the GUID of the PCMark10BatteryProfile, and use it in the following command to set the new power plan to active:
   a. powercfg -setactive *guid-name*

Configure power plan manually

Create a power plan with the following settings:

TURN OFF THE DISPLAY	Never
PUT THE COMPUTER TO SLEEP	Never

Set the following advanced power settings:

HARD DISK	Turn off hard disk after	3 minutes
WIRELESS ADAPTER SETTINGS	Power Saving Mode	Maximum power saving

SLEEP	Sleep after	Never
	Allow hybrid sleep	Off
	Hibernate after	Never
	Allow wake timers	Disable
USB SETTINGS	USB selective suspend setting	Enabled
PCI EXPRESS	Link State Power Management	Maximum power savings
PROCESSOR POWER MANAGEMENT	Minimum processor state	5%
	Maximum processor state	100%
DISPLAY	Turn off display after	Never
	Enable adaptive brightness	Off
MULTIMEDIA SETTINGS	Video playback quality bias	Video playback power-saving bias
	When playing video	Optimize video quality
BATTERY	Critical battery action	Hibernate (on battery), Do nothing (plugged)
	Low battery level	0%
	Critical battery level	0%
	Low battery notification	Off
	Low battery action	Do nothing

Recommended process

The battery must be at least 80% charged before you can start a battery life test. We recommend starting the test with a fully charged battery. The benchmark will run until the PC goes into hibernation or shuts down. PCMark 10 will report the battery life after you restart the computer.

1. Reboot the system.
2. Plug in the power cable.
3. Wait until the system battery is fully charged.
4. Open PCMark 10 application and start a Battery Life test.
5. Unplug the power cable when prompted.
6. The benchmark will run until the battery is depleted.
7. After the system has switched off, plug in the power cable and turn the system back on.
8. If PCMark 10 is still running, it will complete the test and present the result. If PCMark 10 is no longer running due to the system shutting down, start the application manually. PCMark 10 will then recover the files saved during the benchmark run and present the result.

HOW TO TEST STORAGE PERFORMANCE

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.

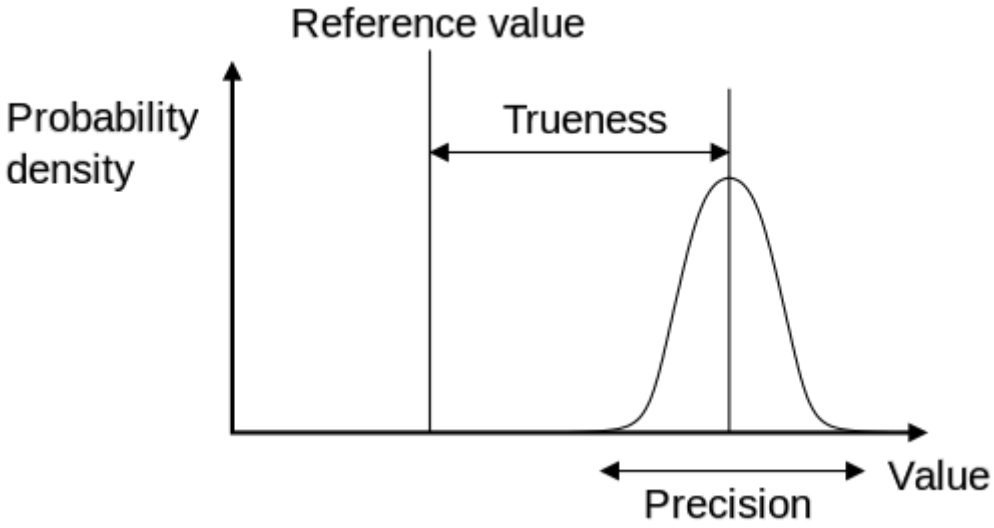
Expert process

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.

⚠ The expected useful life of some storage devices is based on the number of write-erase cycles they perform. Running storage benchmarks repeatedly may shorten the life time of some drives. This is especially true of the long-running and extremely demanding PCMark 10 Drive Performance Consistency Test.

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 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 modern, multitasking operating systems that cannot be controlled completely. 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 take an average or a mode of the results.

LATEST VERSION NUMBERS

	VERSION
PCMark 10 application	2.1.2508
PCMark 10 benchmark	1.0
PCMark 10 Express benchmark	1.0
PCMark 10 Extended benchmark	1.0
PCMark 10 Applications benchmark	1.1
PCMark 10 Battery Life Profile	1.0
PCMark 10 Storage Benchmarks	1.0

Application version number

The application version number applies to the software as a whole. It changes often as we update the application 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

UL 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
OS[3]	Windows 7 SP1 64-bit	Windows 7 SP1 64-bit[4]
PROCESSOR	Dual core processor	Dual core processor
MEMORY	4 GB	2 GB
GRAPHICS	DirectX 11 GPU	DirectX 11 GPU
DISPLAY	1920 × 1080	1280 × 720
DISPLAY SCALING FACTOR[5]	100%	100%
STORAGE	6 GB free space	6 GB free space

	PCMARK 10 EXTENDED	APPLICATIONS
OS	Windows 7 SP1 64-bit	Windows 10
PROCESSOR	Dual core processor	Dual core processor
MEMORY	4 GB	2 GB
GRAPHICS	DirectX 11 GPU with 1 GB memory	DirectX 11 GPU
DISPLAY	1920 × 1080	1280 × 720
DISPLAY SCALING FACTOR	100%	100%
STORAGE	6 GB free space	2 GB of free space

[3] Including all available Windows updates.

[4] A 32-bit version is provided but is not supported.

[5] Using a different DPI scaling will affect your score and may affect stability on some hardware.

	MODERN OFFICE, VIDEO, GAMING, AND IDLE BATTERY LIFE	APPLICATIONS BATTERY LIFE
OS	Windows 7 SP1 64-bit[6]	Windows 10
PROCESSOR	Dual core processor	Dual core processor
MEMORY	4 GB	2 GB
GRAPHICS	DirectX 11 GPU with 1 GB memory	DirectX 11 GPU
DISPLAY	1920 × 1080	1280 × 720
DISPLAY SCALING FACTOR	100%	100%
STORAGE	4 GB free space	2 GB of free space

To run PCMark 10 Applications benchmark, you must have the relevant applications from Microsoft Office 2013 or later installed on the system under test.

	FULL SYSTEM DRIVE BENCHMARK	QUICK SYSTEM DRIVE BENCHMARK
OS	Windows 10 x64 Version 1709 Fall Creators Update or later	Windows 10 x64 Version 1709 Fall Creators Update or later
PROCESSOR	Quad core processor	Quad core processor
MEMORY RAM	8 GB	4 GB
STORAGE	80 GB free space	10 GB free space

[6] A 32-bit version is provided but is not supported.

	DATA DRIVE BENCHMARK	DRIVE PERFORMANCE CONSISTENCY TEST
OS	Windows 10 x64 Version 1709 Fall Creators Update or later	Windows 10 x64 Version 1709 Fall Creators Update or later
PROCESSOR	Quad core processor	Quad core processor
MEMORY RAM	4 GB	8 GB
STORAGE	10 GB free space	80 GB free space

HOW TO USE PCMARK 10

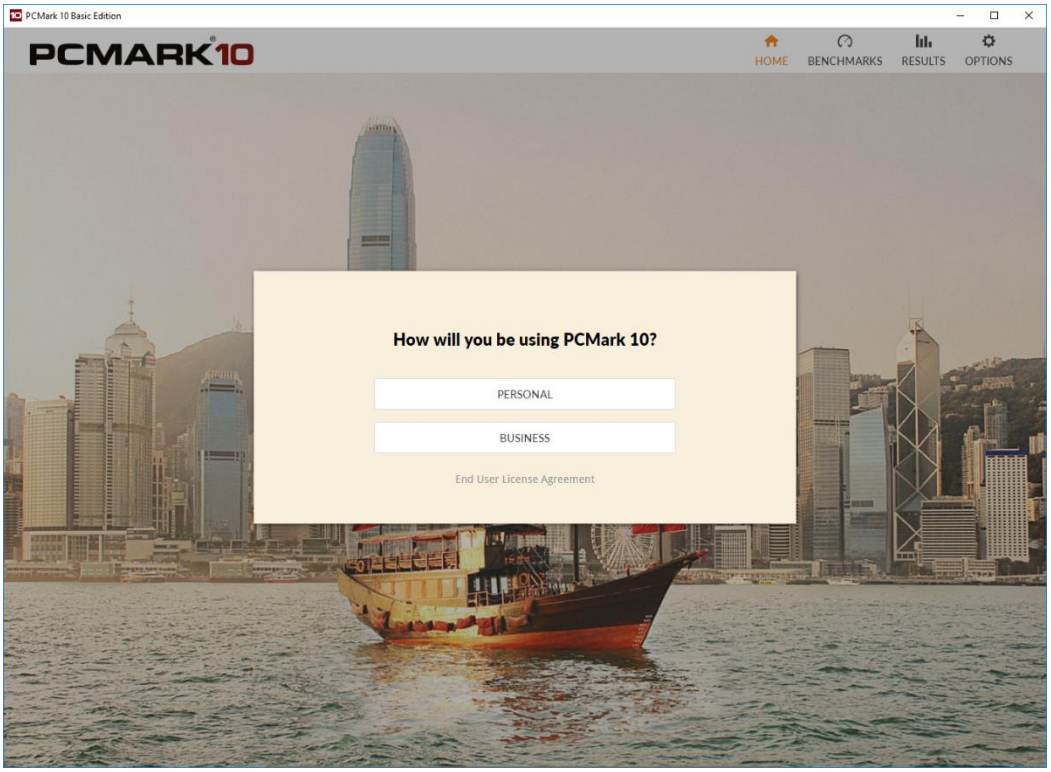
We redesigned the PCMark 10 app in May 2019. The new app adds Battery Life testing and a new Applications benchmark. The update also makes it easier to manage your PCMark 10 benchmark results directly in the app.

Licensing

After installing and running PCMark 10 for the first time, the application will ask whether you will be using the app for Business or Personal use.

Business users must have a Professional Edition license to use PCMark 10. Please contact UL.BenchmarkSales@ul.com if you do not have a license.

PCMark 10 Basic Edition and Advanced Edition are licensed for personal, non-commercial use only. You must not use them for business purposes.



HOME SCREEN

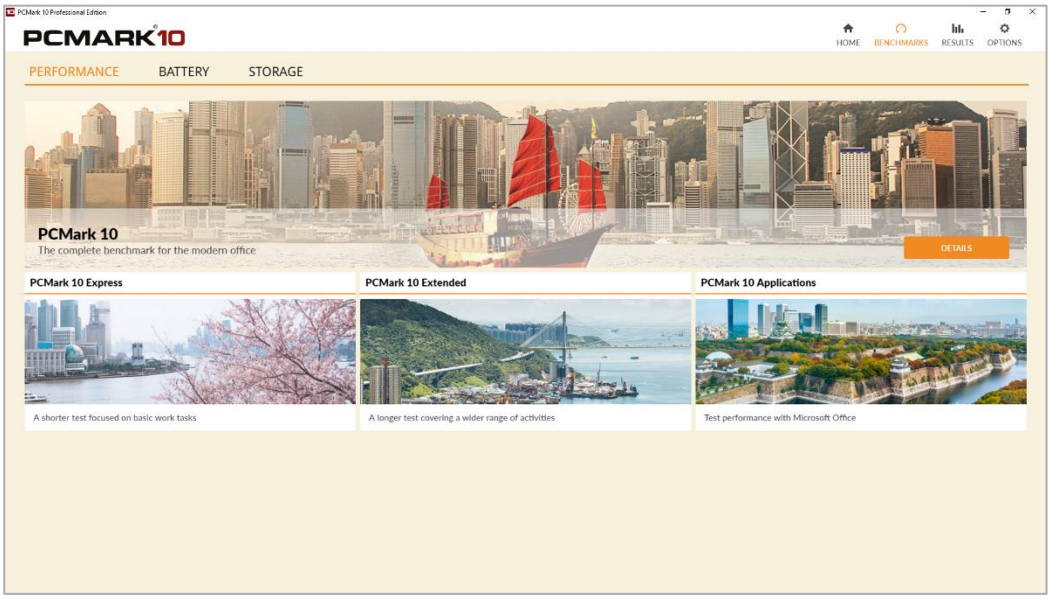
You can start the PCMark 10 benchmark test directly from the Home page by clicking the **Run** button, or select **More Tests** to choose a different test.

BENCHMARKS SCREEN

The **Benchmarks** screen has tabs that separate **Performance** benchmarks, **Storage** benchmarks and **Battery** life tests.

Performance benchmarks

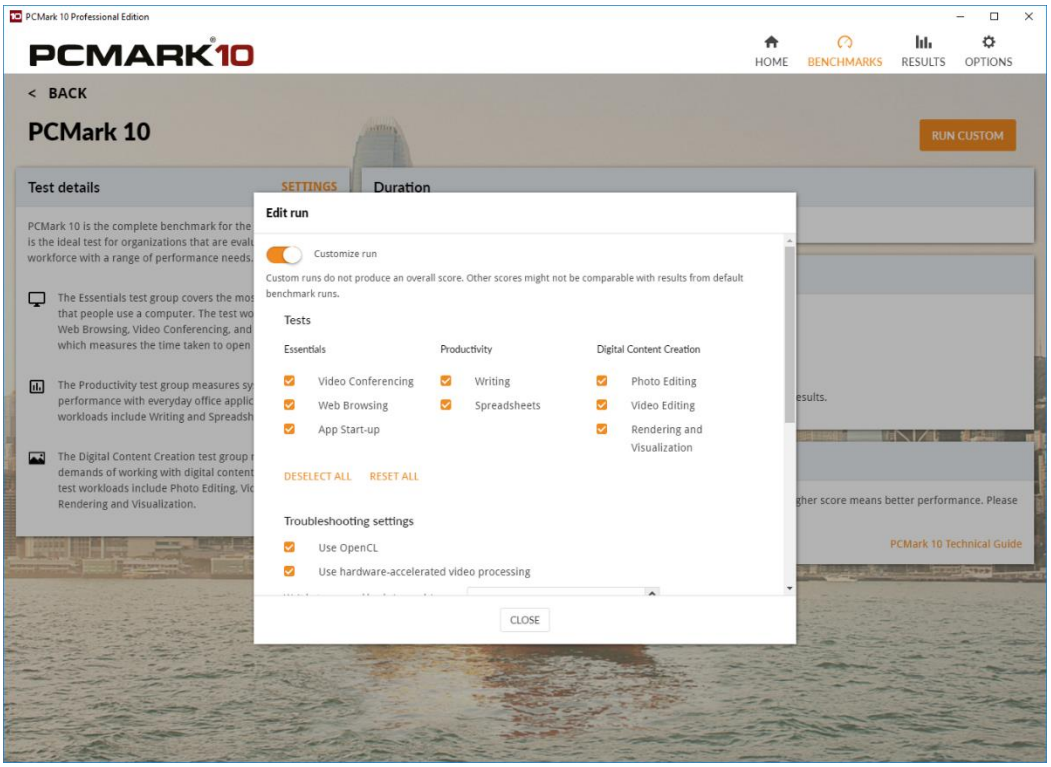
- PCMark 10
- PCMark 10 Express
- PCMark 10 Extended
- PCMark 10 Applications



Click on a test to see the **Test Details** screen, which describes the test and provides useful set up information. Click the **Run** button to start the benchmark with default settings.

Click on **Settings** to customize the benchmark run. You can include or exclude individual workloads and change other settings as needed.

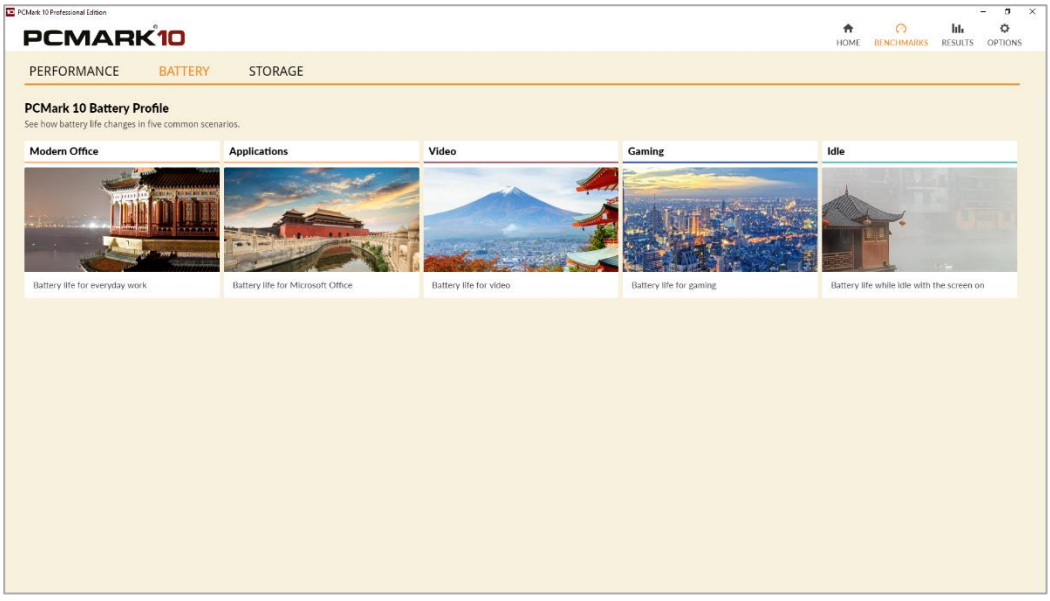
> ⚠ Please note that custom runs do not produce an overall score.



Battery life benchmarks

PCMark 10 has five scenarios for testing battery life:

- Modern Office
- Applications
- Video
- Gaming
- Idle



Click on a battery life test to open the **Test Details** screen, which describes the test and provides useful set up information. Click the **Run** button to start the test.

Each scenario runs until the system shuts down or goes into hibernation. This may take many hours on some devices. PCMark10 reports the system's battery life when the PC is restarted.

> ⚠ Make sure the battery is fully charged. The test will not start if the battery is below 80% charged.

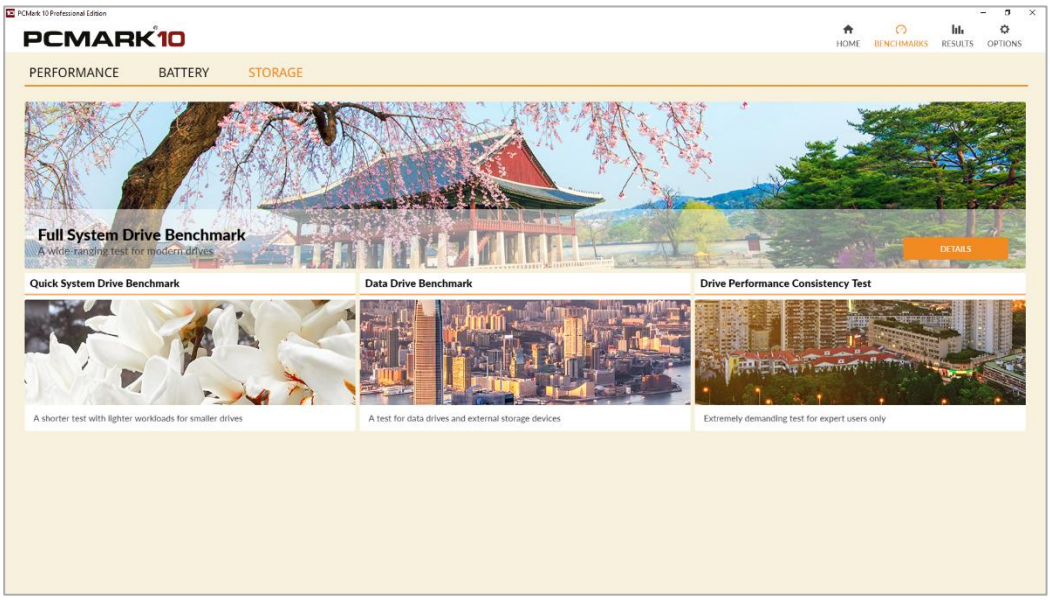
The Modern Office and Applications scenarios offer custom settings Click on **Settings** to customize the benchmark run. Hit **Run** to start the custom run.

> ⚠ Please note that results from custom runs are not comparable with results from the default scenarios.

Storage benchmarks

PCMark 10 includes four storage benchmarks:

- Full System Drive Benchmark
- Quick System Drive Benchmark
- Data Drive Benchmark
- Drive Performance Consistency Test

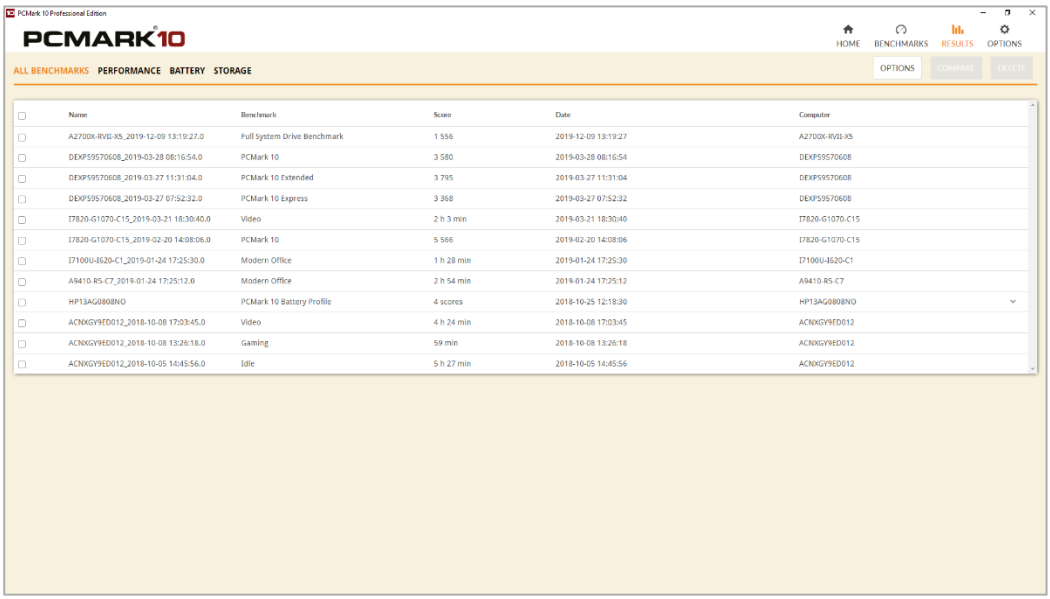


Click on a storage test to open the **Test Details** screen, which describes the test and provides useful set up information. Click the **Run** button to start the test.

RESULTS SCREEN

The **Results** screen shows results from the current system.

The **All Benchmarks** view lists all available results. Choose the **Performance**, **Battery** or **Storage** view to show only those results.



You can import results from other systems by clicking on the **Options** button and selecting **Import result**.

To rename a result file or add a description, right-click on the result and choose **Edit result**. To delete results, first select the results, then click **Delete**. Alternatively, you can right-click on a result and choose **Delete**.

Result details screen

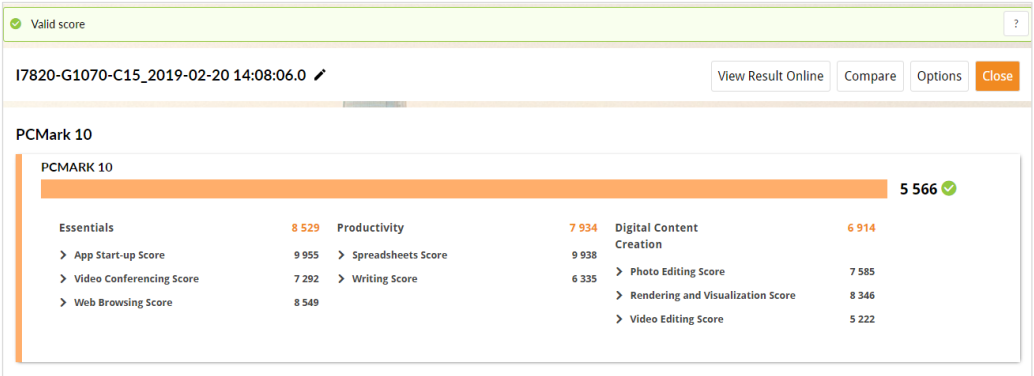
Double-click on a result to open it or right-click and choose **View result**.

The result screen is divided into sections.

- Benchmark scores
- Monitoring
- Additional Outputs
- System information.

Benchmark scores

PCMark 10 performance benchmarks produce several scores and results. The overall benchmark score is the top-level result, ideal for comparing systems. The higher the score, the better the performance.



Below the overall score, you'll find a score for each of the benchmark's test groups. A test group is a collection of workloads that share a common theme or purpose.

Under each test group score, you'll see its workloads and their scores. A workload is a test designed around a specific activity, task, or application. You can expand a workload to see its low-level results.

PCMark 10 Battery Life test results are presented in hours and minutes. The Modern Office battery life scenario also produces a performance score in addition to its battery life result.

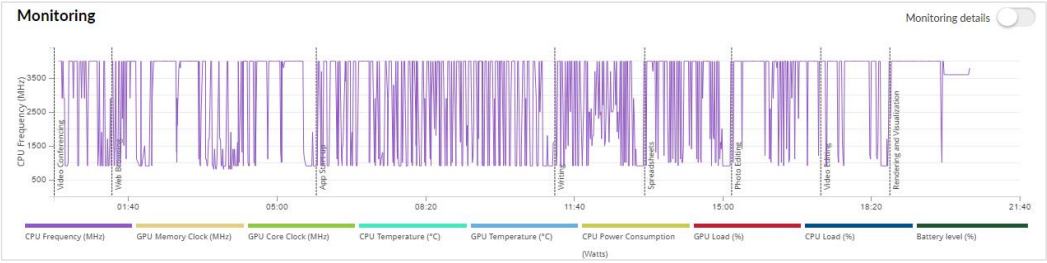
The score validation box is either green, showing 'Valid score' if the result passes our checks; or red, showing details of any errors or problems with the run. You can click on the **[?]** icon in both cases for more information.

Monitoring

In PCMark 10 Advanced Edition and Professional Edition, the benchmark result includes hardware monitoring charts. Use these charts to see how various metrics changed during the test. Monitoring is not available for Battery Life results.

Click on the legend to see the monitoring chart for the chosen metric. Click on **Monitoring details** to expand the view and see all the charts at once.

Move your mouse 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.



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

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

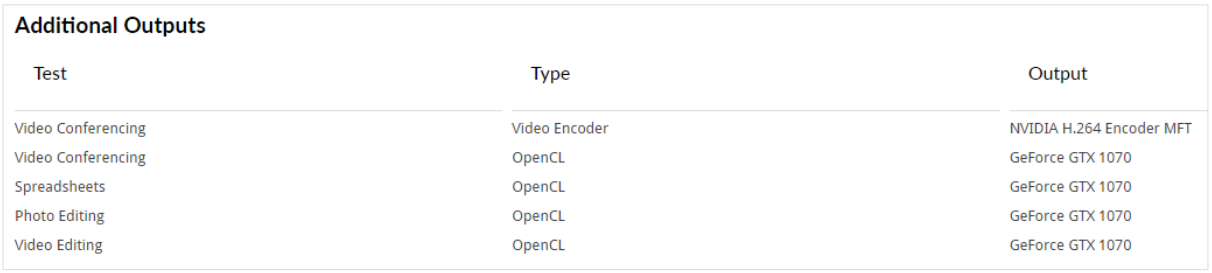
Power Consumption shows how CPU power consumption changed during the benchmark run.

GPU Load shows how GPU load changed during the benchmark run.

Battery how the battery charge level changed during the benchmark run.

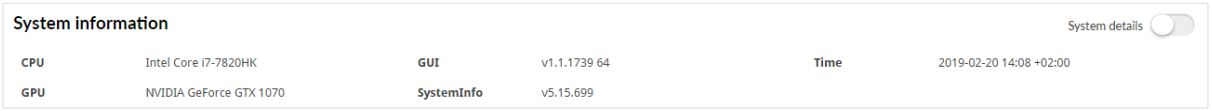
Additional Outputs

This section lists the devices that were used by the APIs for the benchmark run. These details can be used in interpreting the results.



System information

This section of the result screen 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.



In the PCMark 10 Advanced Edition and Professional Edition, you can expand this section to see more hardware details.

Compare results

You can compare up to four results side-by-side in PCMark Advanced Edition and Professional Edition.

You can compare PCMark 10 scores directly in the app. Select at least two results from the **Results** screen, then click the **Compare** button. Or, from the **Result details** view, click the **Compare** button then select another result from the list. Please note that you can only compare scores from the same test.

> ⚠ Scores from different PCMark 10 tests are not comparable. Each test produces its own score. You should only compare scores from the same test.

Result export

In PCMark 10 Professional Edition, you can export results as PDF or XML.

The PDF result report includes hardware monitoring graphs to provide a full view of the benchmark run making it easier to store and share test results. The PDF report can also be customized with your own logo. Go to the **Options** screen in PCMark 10 application to setup your logo file.

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
- Russian
- Simplified Chinese

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, disabled by default.

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 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.

Version details

Shows the version number of the app, SystemInfo and system benchmarks. Use **Check for updates** to see if there are new version updates.

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.

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.

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 carrying out a selection of typical web browsing tasks.

PCMARK 10 PERFORMANCE BENCHMARKS

There are four performance benchmarks in 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.
- PCMark 10 Applications – benchmark performance with Microsoft apps.

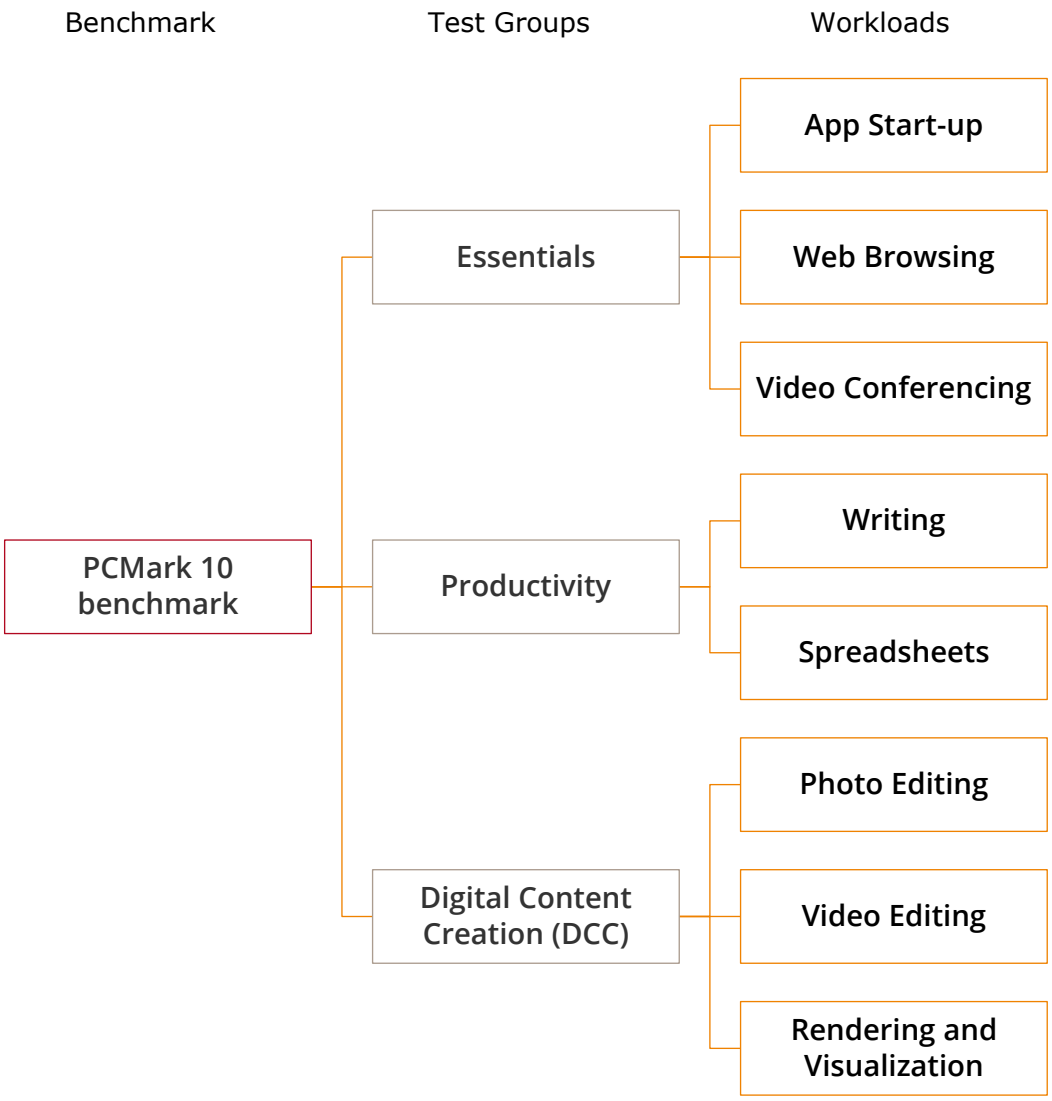
Each benchmark contains a number of test groups. A test group is a collection of workloads that share a common theme or purpose.

	PCMARK 10	PCMARK 10 EXPRESS	PCMARK 10 EXTENDED	PCMARK 10 APPLICATIONS
ESSENTIALS	●	●	●	×
PRODUCTIVITY	●	●	●	×
DIGITAL CONTENT CREATION	●	×	●	×
GAMING	×	×	●	×
MICROSOFT APPLICATIONS	×	×	×	●

⚠ You can force every test to run on Arm-powered devices from the command line. Note that some workloads in PCMark 10 benchmark and PCMark 10 Extended are not compatible with Arm devices, which means you will not get an overall score for these tests.

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.



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:

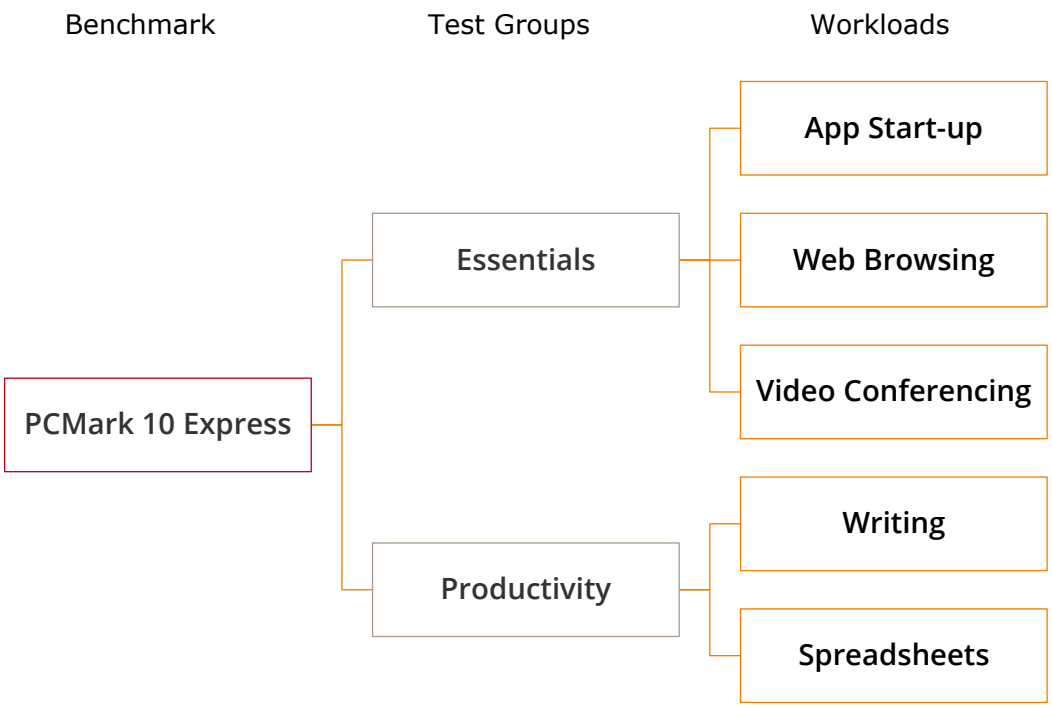
$D_1 = Photo\ Editing\ score$

$D_2 = Video\ Editing\ score$

$D_3 = Rendering\ and\ Visualization\ score$

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.



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:

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

$E_2 = Web\ Browsing\ score$

$E_3 = Video\ Conferencing\ score$

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

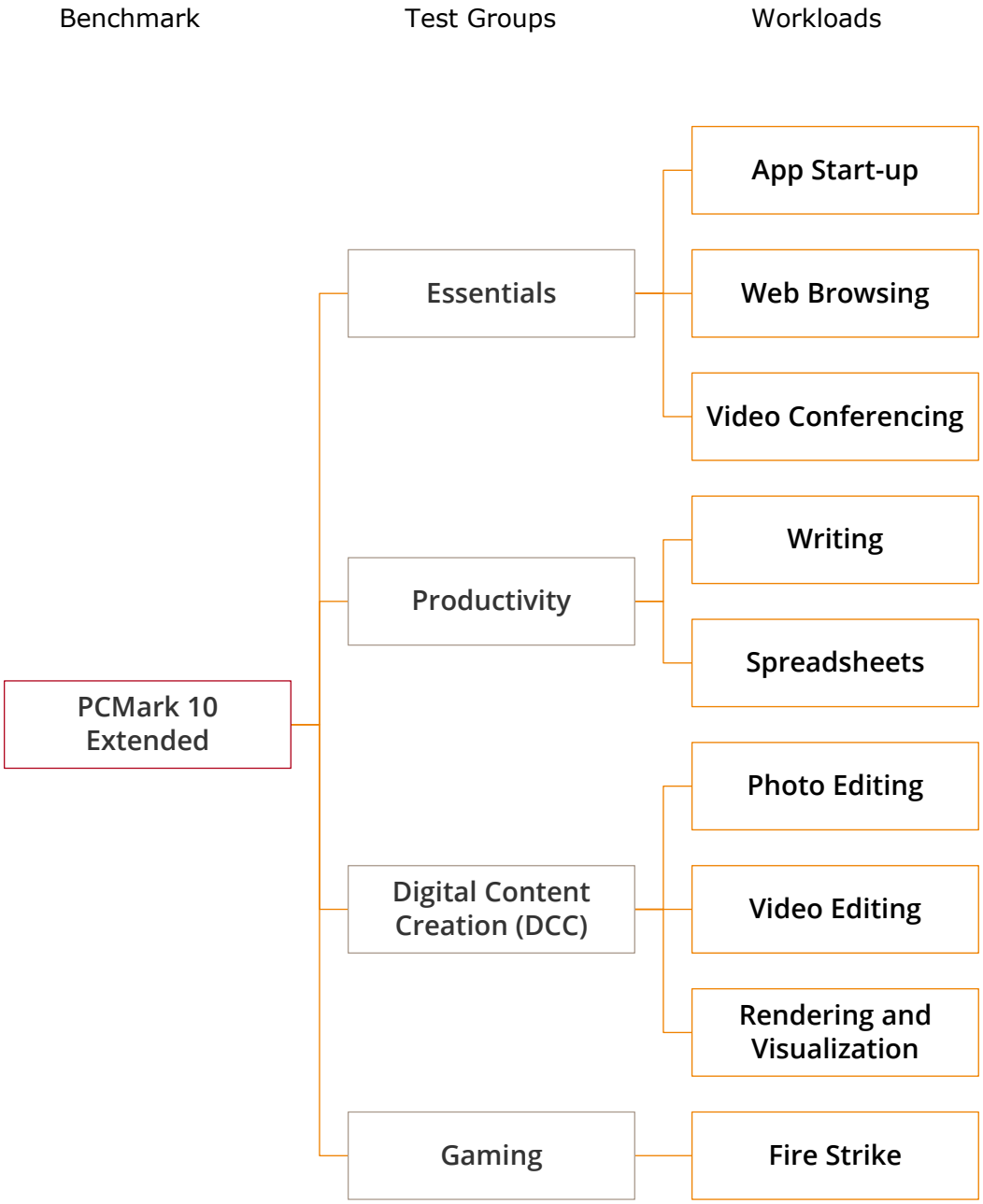
Where:

$P_1 = Writing\ score$

$P_2 = Spreadsheets\ score$

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.



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
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

RESULT	DEFINITION	UNIT	TYPICAL RANGE
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
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

RESULT	DEFINITION	UNIT	TYPICAL RANGE
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
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	-

RESULT	DEFINITION	UNIT	TYPICAL RANGE	GEOMETRIC MEAN WEIGHT
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
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 UL.

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
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

RESULT	DEFINITION	UNIT	TYPICAL RANGE
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 a POV-Ray build created by UL. 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[7]	COMPUTE SHADER INVOCATIONS
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
2.6 MILLION	240,000	5.8 million	170 million	8.1 million

[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.

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[8]	Compute shader invocations
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.

[8] 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.

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

Where:

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

$Wgraphics$	=	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:

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

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

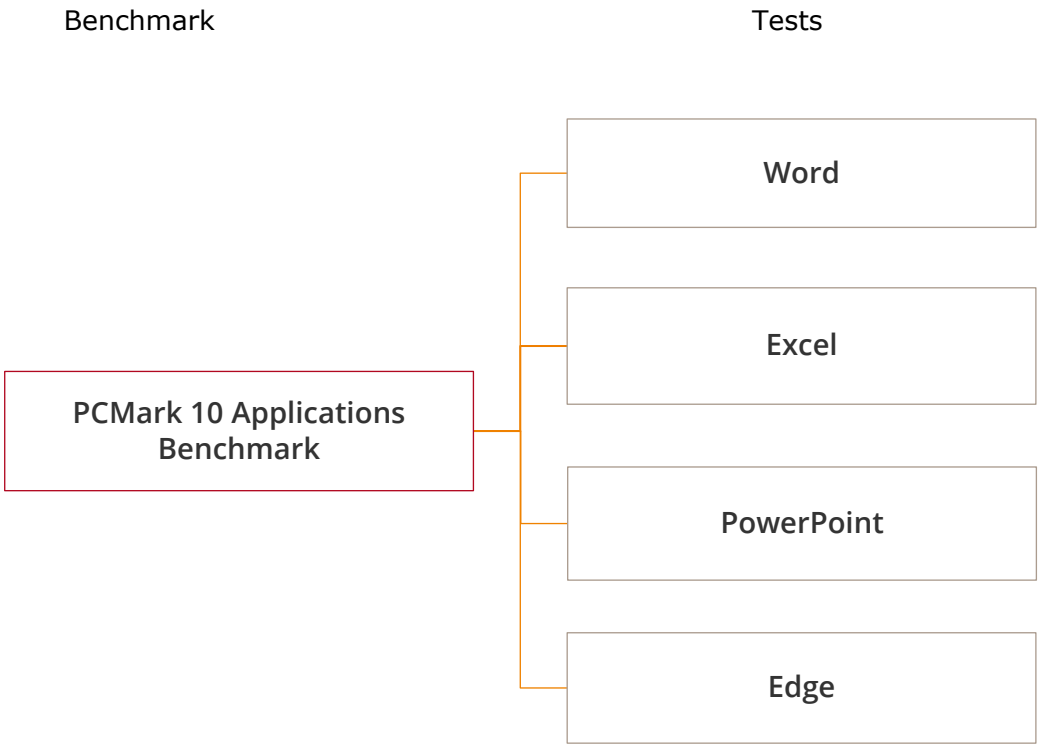
The scaling constant is used to bring the score in line with traditional 3DMark score levels.

Find more details in 3DMark Technical Guide.

PCMARK 10 APPLICATIONS BENCHMARK

The PCMark 10 Applications benchmark is based on Microsoft Office applications. Featuring tests that run in Word, Excel, PowerPoint, and Microsoft Edge, the PCMark 10 Applications benchmark helps you measure practical, real-world performance for the modern office.

You can also benchmark the latest Snapdragon-powered Always Connected PCs running Windows 10 on Arm, with results that are comparable with scores from traditional x86-based devices.



⚠ To run the PCMark 10 Applications benchmark, you must have Microsoft Office installed on the PC under test. The test is compatible with Microsoft Office 2013, Microsoft Office 2016, Microsoft Office 2019, and Microsoft Office 365. The Microsoft Office installation must be registered and, if required, you should sign in.

Scoring

Overall score

$$PCMark\ 10\ Applications\ Benchmark\ score = K * geomean(S_1, S_2, S_3, S_4)$$

Where:

$K =$ scoring coefficient $= 1$

$S_1 = Microsoft\ Word\ score$

$S_2 = Microsoft\ Excel\ score$

$S_3 = Microsoft\ PowerPoint\ score$

$S_4 = Microsoft\ Edge\ score$

WORD TEST

The Word test models common tasks when working with documents in Microsoft Word.

Implementation

The test design is similar to the PCMark 10 Writing test.

Workloads

The Word test simulates typical tasks when working with Microsoft Word, such as opening, editing, and saving a document. The workload performs the following tasks:

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

The test measures the time it takes to start, load, edit, save, and add pictures.

$$Start\ Microsoft\ Word = geomean(M_1, M_2, M_3)$$

Where:

$$M_1 = dbg\_pcm10\_microsoft\_word\_start\_0$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_start\_1$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_start\_2$$

$$Load\ Microsoft\ Word = geomean(M_1, M_2, M_3, M_4, M_5, M_6)$$

Where:

$$M_1 = dbg\_pcm10\_microsoft\_word\_load\_source\_0$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_load\_source\_1$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_load\_source\_2$$

$$M_4 = dbg\_pcm10\_microsoft\_word\_load\_destination\_0$$

$$M_5 = dbg\_pcm10\_microsoft\_word\_load\_destination\_1$$

$$M_6 = dbg\_pcm10\_microsoft\_word\_load\_destination\_2$$

$$Copy\ and\ paste = geomean(M_1, M_2, M_3, M_4, M_5, M_6, M_7)$$

Where:

$$M_1 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_0$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_1$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_2$$

$$M_4 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_3$$

$$M_5 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_4$$

$$M_6 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_5$$

$$M_7 = dbg\_pcm10\_microsoft\_word\_copy\_paste\_6$$

$$Save\ document = geomean(M_1, M_2, M_3, M_4, M_5, M_6, M_7)$$

Where:

$$M_1 = dbg\_pcm10\_microsoft\_word\_save\_as\_first$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_save\_second$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_add\_image\_save\_0$$

$$M_4 = dbg\_pcm10\_microsoft\_word\_add\_image\_save\_1$$

$$M_5 = dbg\_pcm10\_microsoft\_word\_add\_image\_save\_2$$

$$M_6 = dbg\_pcm10\_microsoft\_word\_add\_image\_save\_3$$

$$M_7 = dbg\_pcm10\_microsoft\_word\_add\_image\_save\_4$$

$$Resize\ document = M_1 - M_2 - M_3 - M_4$$

Where:

$$M_1 = dbg\_pcm10\_microsoft\_word\_resize\_total$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_resize\_frame\_min$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_resize\_frame\_max\_0$$

$$M_4 = dbg\_pcm10\_microsoft\_word\_resize\_frame\_max\_1$$

$$Cut\ and\ paste = geomean(M_1, M_2, M_3, M_4, M_5, M_6, M_7)$$

Where:

$$M_1 = \ dbg\_pcm10\_microsoft\_word\_cut\_paste\_0$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_cut\_paste\_1$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_cut\_paste\_2$$

$$M_4 = dbg\_pcm10\_microsoft\_word\_cut\_paste\_3$$

$$M_5 = dbg\_pcm10\_microsoft\_word\_cut\_paste\_4$$

$$M_6 = dbg\_pcm10\_microsoft\_word\_cut\_paste\_5$$

$$M_7 = dbg\_pcm10\_microsoft\_word\_cut\_paste\_6$$

$$\text{Type text} = M$$

Where:

$$M = \ dbg\_pcm10\_microsoft\_word\_type\_text\_chars$$

$$Add\ image\ to\ document = geomean(M_1, M_2, M_3, M_4, M_5)$$

Where:

$$M_1 = \ dbg\_pcm10\_microsoft\_word\_add\_image\_0$$

$$M_2 = dbg\_pcm10\_microsoft\_word\_add\_image\_1$$

$$M_3 = dbg\_pcm10\_microsoft\_word\_add\_image\_2$$

$$M_4 = dbg\_pcm10\_microsoft\_word\_add\_image\_3$$

$$M_5 = dbg\_pcm10\_microsoft\_word\_add\_image\_4$$

Scoring

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

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

Where:

$$K = scoring\ coefficient = 3763$$

RESULT	DEFINITION	UNIT	TYPICAL RANGE
R_1	Start application	s	0.3 - 2.0
R_2	Load document	s	0.2 - 1.7
R_3	Copy and paste	s	0.2 - 1.1
R_4	Save document	s	0.2 - 0.6
R_5	Resize document	s	0.3 - 1.2
R_6	Cut and paste	s	0.3 - 0.9
R_7	Type text	s	3.7 - 23
R_8	Add pictures to document	s	0.6 - 1.6

EXCEL TEST

The Excel test models common tasks when working with spreadsheets in Microsoft Excel.

Implementation

The test design is similar to the PCMark 10 Spreadsheets workload.

The test covers two scenarios:

- Common use
- Power user

Common use

The Common use scenario uses a spreadsheet that is similar to the spreadsheet used in the PCMark 10 Spreadsheets Part 1 workload.

Power user

The Power user scenario uses the Building Design and Stock History spreadsheets from the PCMark 10 Spreadsheets Part 2 workload. These spreadsheets are available from the LibreOffice repository.

Workloads

Common use scenario

The common use scenario simulates work with simple spreadsheets in Microsoft Excel. The workload performs the following tasks:

1. Start Microsoft Excel
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 user scenario

The power user scenario simulates working with more complex spreadsheets in Microsoft Excel. The workload performs the following tasks:

1. Load sheets with advanced formulas and big data sets.
2. Recalculate data.
3. Save the file.

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

Scoring

The Microsoft Spreadsheets test score formula uses a geomean of the workload results to calculate the overall score.

$$Microsoft\ Excel\ score = K * \frac{1}{geomean(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10}, R_{11}, R_{12})}$$

Where:

$$K = scoring\ coefficient = 7960$$

RESULT	DEFINITION	UNIT	TYPICAL RANGE
R_1	Start application	s	0.3 - 0.7
R_2	Open document	s	1.2 - 4.0
R_3	Resize document	s	0.4 - 1.5
R_4	Copy data and compute	s	0.6 - 3.2
R_5	Copy plain data	s	0.1 - 0.5
R_6	Copy formulas	s	0.1 - 0.3
R_7	Copy data and compute 2	s	0.7 - 3.5
R_8	Edit cells	s	1.4 - 5.8
R_9	Save document	s	1.6 - 8.5

RESULT	DEFINITION	UNIT	TYPICAL RANGE
R_{10}	Recalculate Building design	s	0.5 - 7.5
R_{11}	Recalculate Stock history	s	1.1 - 12
R_{12}	Close workbook	s	0.1 - 0.4

POWERPOINT TEST

The PowerPoint test models common tasks when working with presentations in Microsoft PowerPoint.

Implementation

The PowerPoint test builds upon PCMark 8 Microsoft PowerPoint test.

Workloads

The PowerPoint test simulates working with Microsoft PowerPoint presentations by making a series of edits to an image-rich PowerPoint file. The workload performs the following tasks:

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

Scoring

The PowerPoint test score formula uses a geomean of the workload results to calculate the overall score.

$$Microsoft\ PowerPoint\ score = K * \frac{1}{geomean(R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10})}$$

Where:

$$K = scoring\ coefficient = 3750$$

RESULT	DEFINITION	UNIT	TYPICAL RANGE
R_1	Start application	s	0.2 – 0.6
R_2	Open document	s	0.5 – 2.3
R_3	Resize document	s	0.1 – 0.5

RESULT	DEFINITION	UNIT	TYPICAL RANGE
R_{4}	Browse document	s	0.1 – 0.2
R_{5}	Add slide	s	0.8 – 2.5
R_{6}	Add image	s	0.2 – 0.8
R_{7}	Add text	s	0.6 – 1.8
R_{8}	Add video	s	1.0 – 3.0
R_{9}	Export to PDF	s	2.8 – 8.2
R_{10}	Save document	s	0.2 – 2.1

EDGE TEST

The Edge test models common home and office web browsing activities such as social media, online shopping, viewing maps, watching video, and browsing static web pages with the Microsoft Edge browser.

Implementation

The Edge test is similar to the PCMark 10 Web Browsing workload. The workload uses Microsoft Edge. Other browsers installed on the system will not affect the result.

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 popular web sites.

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.

Online shopping

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

- The user views shopping items in high resolution and zooms into the image.
- The user views items in a 3D model presentation.

Map

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

- The user navigates to the map site.
- The page adds some useful graphics such as traffic information.
- The user zooms into the map.

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.

Scoring

The Edge test score formula uses a geomean of the workload results to calculate the overall score.

$$Microsoft\ Edge\ score = K * geomean\left(\frac{1}{R_1}, \frac{1}{R_2}, R_3, \frac{1}{R_4}, \frac{1}{R_5}, R_6\right)$$

Where:

$$K = scoring\ coefficient = 772$$

$$R_3 = Shop\ view = geomean(A_1, A_2)$$

$$R_6 = Video\ view = geomean(A_3, A_4)$$

RESULT	DEFINITION	UNIT	TYPICAL RANGE
R_1	Social media page load	s	0.1 - 0.4
R_2	Social media feed update	s	0.1 - 0.3
R_4	Shop load 3D object	s	1.2 - 2.8
R_5	Map infographics update	s	0.1 - 0.4
A_1	Shop view image	FPS	60
A_2	Shop animate 3D object	FPS	60
A_3	Video 1080p H.264	FPS	30
A_4	Video 2160p H.264	FPS	30

PCMARK 10 BATTERY LIFE PROFILE

Battery life is one of the most important criteria for choosing a laptop, but consumers and businesses find it hard to compare systems fairly. The challenge is that battery life depends on how a device is used.

PCMark 10 introduces a new approach to battery life benchmarking. Instead of producing a single number, the PCMark 10 Battery Life Profile provides a broad view of battery life across five common scenarios: modern office, applications, video, gaming, and idle time.

PCMark 10 battery life tests run until the PC goes into hibernation or shuts down. The reported battery life is the battery life measured during the test.

The battery must be at least 80% charged before you can start a battery life test, but we recommend starting a test with a fully charged battery.

BATTERY LIFE SCENARIOS

PCMark 10 Battery Life Profile is based on five common scenarios:

- Modern Office - battery life for everyday work tasks.
- Applications - battery life using Microsoft Office and Microsoft Edge
- Video - battery life for video
- Gaming - battery life for gaming
- Idle - battery life while idle with the screen on

The Modern Office and Video scenarios reflect two of today's most common use cases. The Gaming and Idle scenarios produce the lower and upper limits of battery life for practical use.

PCMark 10 Applications scenario measures battery life using popular Microsoft applications. These include work with documents, spreadsheets, presentations and web browsing.

PCMark 10 Applications scenario measures PC battery life during light to medium office work using Microsoft Office and Microsoft Edge applications. You can use this scenario to test the battery life of the latest Always Connected PCs powered by Windows 10 on Arm.

> The PCMark 10 Modern Office and Gaming battery life scenarios are not compatible with Always Connected PCs powered by Windows 10 on Arm.

⚠ You can force every test to run on Arm-powered devices from the command line. Note that the workloads in the Modern Office and Gaming battery life scenarios are not optimized for Arm devices. Therefore, the results from these scenarios cannot be used as a representative battery life for these devices.

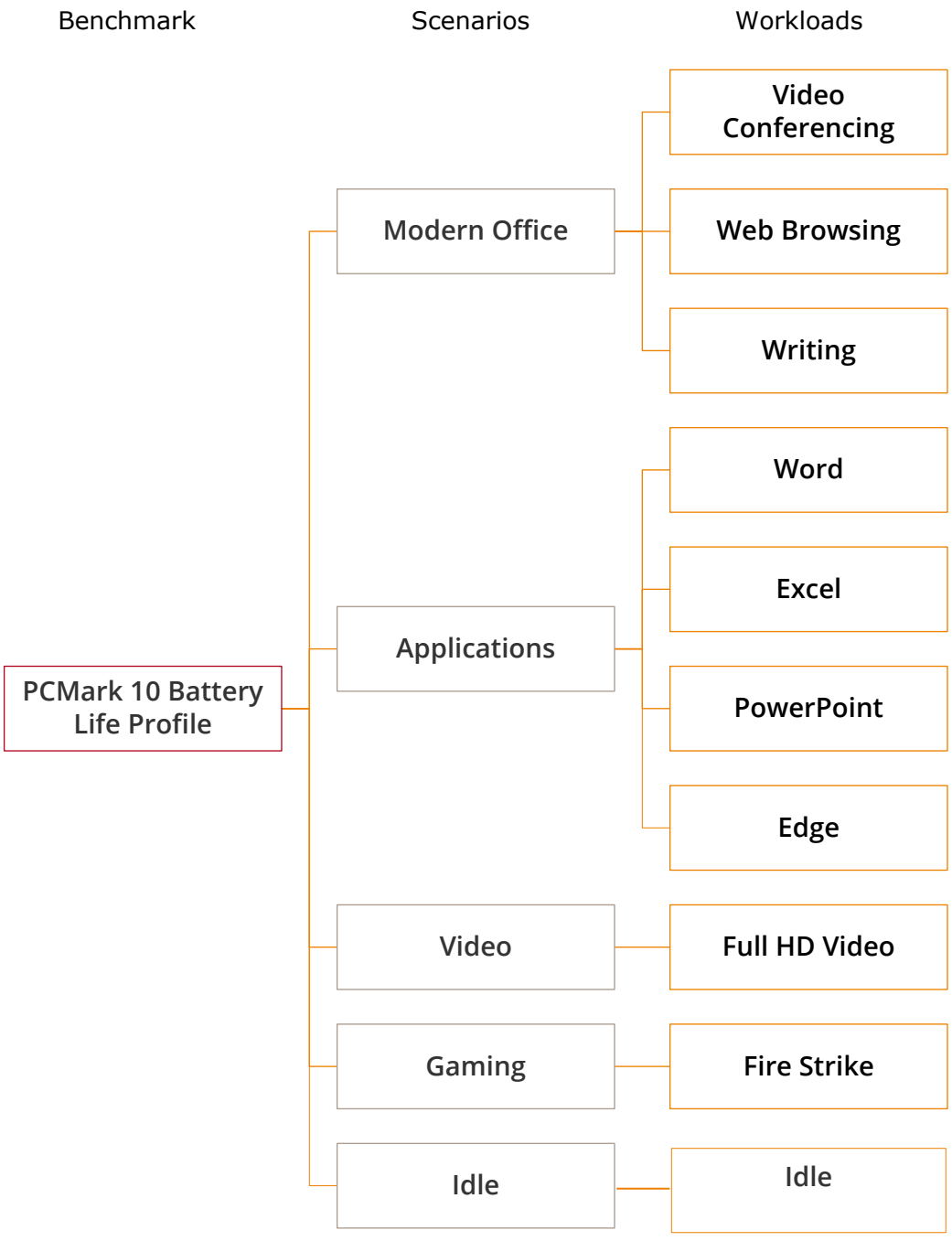
BATTERY LIFE WORKLOADS

Each battery life scenario is based on a common activity.

The Modern Office scenario includes three workloads that reflect typical office tasks: video conferencing, web browsing and writing documents.

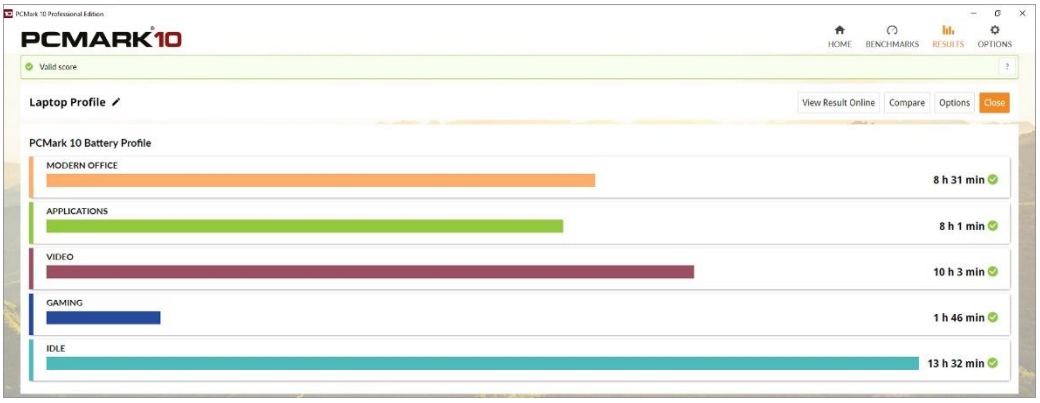
The Applications scenario includes four workloads that represent typical office work with Microsoft Office and Microsoft Edge.

The other three scenarios are based on a single workload.



BATTERY LIFE PROFILE

The PCMark 10 Battery Life Profile allows you to compare the performance of your system across all the battery life scenarios in one view.

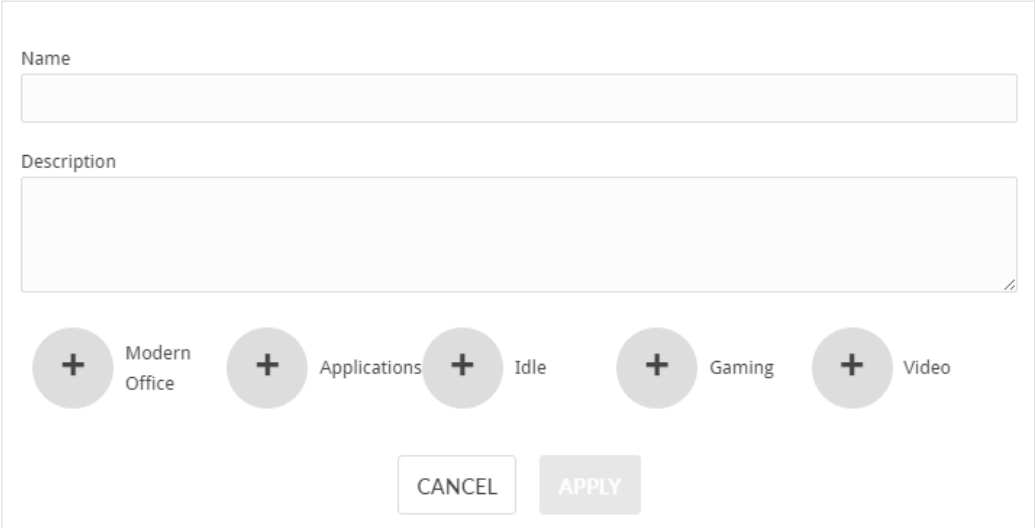


Run the battery life tests or import results to PCMark 10 application by following these steps:

1. Go to the **Results** screen
2. Click on **Options**
3. **Import result**.

To create a Battery Life Profile, follow these steps:

1. Go to the **Results** screen
2. Choose **Create new profile**
3. Add a **Name** and **Description**
4. Add results for each workload
5. Click **Apply**.



> Please note that you can create a Battery Life Profile using results from the same system.

MODERN OFFICE BATTERY LIFE

The PCMark 10 Modern Office scenario measures battery life for light and medium office work. It includes a realistic balance of writing, web browsing, and video conferencing tasks separated by short periods of idle time.

Implementation

The Modern Office test uses the Writing, Web Browsing and Video Conferencing workloads from the main PCMark 10 benchmark.

The Writing workload includes extra periods of idle time in between the timed segments to represent user actions and match the speed at which users performs tasks in the real-world.

The PCMark 10 Modern Office benchmark runs in 10-minute loops. If a workload is completed in less than 10 minutes, the benchmark will idle until the full 10 minutes have elapsed before starting the next loop.

The time data below comes from running the test on a reference machine to illustration the workload and idle behaviour.

TEST	DURATION ON REFERENCE MACHINE
Writing test	10 minutes (4 min 30 sec busy, 5 min 30 sec idle)
Web Browsing	10 minutes (4 min 30 sec busy, 5 min 30 sec idle)
Video Conferencing	10 minutes (2 min busy, 8 min idle)

Benchmark result

The PCMark 10 Modern Office scenario reports the battery life time from the start of the test until the device goes into hibernation or shuts down. The time is reported in hours and minutes.

In addition, it also provides a performance score. This score is the standard geomean of the results produced by the three tests.

$$PCMark\ 10\ Modern\ Office\ Battery\ performance\ score\ for\ each\ pass = K * geomean(R_1, R_2, R_3)$$

Where:

$$R_1 = Writing\ score$$

$$R_2 = Web\ Browing\ score$$

$$R_3 = Video\ Conferencing\ score$$

Where:

$$K = scoring\ coefficient = 1.165$$

These scores are computed as in the PCMark 10 benchmark. Please see the scoring sections for the Writing, Web Browsing and Video Conferring tests in PCMark 10 benchmark section of the technical guide.

⚠ Scores from the PCMark 10 Modern Office Battery Life test and the PCMark 10 benchmark test are not comparable.

APPLICATIONS BATTERY LIFE

The PCMark 10 Applications scenario measures battery life during light and medium office work using Microsoft Office and Microsoft Edge. It includes balanced tasks using Word, Excel, PowerPoint and Edge separated by short periods of idle time.

You can use custom settings to run selected workloads if you wish. Note that scores from custom tests cannot be compared with scores from default runs.

The Applications scenario is compatible with the Snapdragon-powered Always Connected PCs running Windows 10 on Arm. Scores from these devices are comparable with scores from traditional x86-based devices.

Implementation

The PCMark 10 Applications Battery Life scenario includes the same tests as the Applications performance benchmark. These are:

- Word test
- Excel test
- PowerPoint test
- Edge test

PCMark 10 Applications Battery Life scenario runs in 10 minutes loops. If a workload is completed in less than 10 minutes, the benchmark will idle until the full 10 minutes have elapsed before starting the next loop.

The time data below comes from running the test on a reference machine to illustration the workload and idle behaviour.

TEST	DURATION ON REFERENCE MACHINE
Word	10 minutes (2 min busy, 8 min idle)
Excel	10 minutes (2.10 min busy, 7.50 min idle)
PowerPoint	10 minutes (3.15 min busy, 6.45 min idle)
Edge	10 minutes (4.20 min busy, 5.40 min idle)

Benchmark result

PCMark 10 Applications scenario reports battery life time from the start of the test until the device goes into hibernation or shuts down. The time is reported in hours and minutes.

VIDEO BATTERY LIFE

The PCMark 10 Video scenario measures battery life by playing an HD video continuously in full screen mode until the battery is empty.

This type of battery life testing is commonly used by hardware review sites, but results vary across publications due to difference in the video and settings used. The PCMark 10 Video Battery Life test aims to provide an easy-to-use, standardised tool for measuring battery life for video playback.

Implementation

The test play a Full HD video using the Movies and TV application on Windows 10. On Windows 8.1 and Windows 7 the video is played using Windows Media Player.

Specifications for the H.264 video encoding:

- 1920 × 1080 High profile
- Frame rate: 30 FPS
- Resolution: 1920 × 1080
- Square pixels, NTSC
- Profile: HIGH, level 4.0
- Bitrate encoding: VBR 2 pass, target Mbps 10
- Key frame distance: 90
- Audio: AAC, 48kHz, Stereo, Quality High, 320 kbps, precedence bitrate
- Multiplexer: MP4, stream Compatibility Standard

Benchmark result

PCMark 10 scenario reports battery life as the time taken from the start of the test until the PC goes into hibernation or shuts down. The time is reported in hours and minutes.

GAMING BATTERY LIFE

The PCMark 10 Gaming scenario puts the PC under a constant, heavy load that quickly drains the battery. This demanding test determines the lower limit of the PCMark 10 Battery Life Profile.

Implementation

The Gaming Battery Life test uses the 3DMark Fire Strike Graphics test 1 workload. The workload is looped for 15 minutes, after which it is reloaded. The test runs until the battery is empty.

Please see more details about 3DMark Fire Strike Graphics test 1 in the Fire Strike chapter of this technical guide.

Benchmark result

PCMark 10 Gaming scenario reports battery life as the time taken from the start of the test until the PC goes into hibernation or shuts down. The time is reported in hours and minutes.

IDLE BATTERY LIFE

The PCMark 10 Idle scenario measures battery life for the inactive time between tasks to produce the upper limit of the PCMark 10 Battery Life Profile. The screen is kept on during the test. No activity is performed on the system during the test, other than a small amount of CPU load from running the PCMark 10 application.

Implementation

During the PCMark 10 Idle test, the screen is kept on. No other activity is performed on the tested system.

Benchmark result

PCMark 10 Idle scenario reports battery life as the time taken from the start of the test until the PC goes into hibernation or shuts down. The time is reported in hours and minutes.

PCMARK 10 STORAGE BENCHMARKS

PC storage has advanced in exciting new directions in recent years. PC users now have a wide range of options from standard SATA SSDs and hybrid drives to the latest PCIe 4.0 NVMe storage devices and new technologies like Intel's *Optane*.

Unfortunately, many of the tools for measuring storage performance were developed when HDDs were the most common type of drive. And results from synthetic benchmarks can be hard to relate to real-world performance.

PCMark 10 introduces a set of four storage benchmarks that use relevant real-world traces from popular applications and common tasks to fully test the performance of the latest modern drives.

These new benchmarks are for professional users in the media and industry looking for superior tools to test and compare the performance of the latest internal and external storage devices for desktop and laptop PCs.

Effect on device lifetime

The number of bytes written to the drive during testing depends on the test. With default settings, we have measured the following:

- Full System Drive benchmark: 204 GB
- Quick System Drive benchmark: 23 GB
- Data Drive benchmark: 15 GB
- Drive Performance Consistency Test: 23 TB plus up to 3 times the drive capacity.

⚠ The expected useful life of some storage devices is based on the number of write-erase cycles they perform. Running storage benchmarks repeatedly may shorten the life time of some drives. This is especially true of the long-running and extremely demanding PCMark 10 Drive Performance Consistency Test.

STORAGE BENCHMARKS

PCMark 10 introduces a set of four storage benchmarks that use relevant real-world traces from popular applications and common tasks to fully test the performance of the latest modern drives.

FULL SYSTEM DRIVE BENCHMARK	A wide-ranging test for modern drives.
QUICK SYSTEM DRIVE BENCHMARK	A shorter test with lighter workloads for smaller drives.
DATA DRIVE BENCHMARK	A test for data drives and external storage devices.
STORAGE PERFORMANCE CONSISTENCY TEST	An extremely demanding test for expert users.

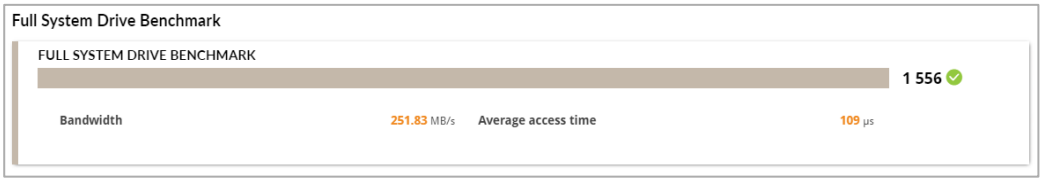
Definitions

Definition of terms used in this chapter:

- **I/O** or operation is the smallest piece of benchmark execution. It can be a read, write, create, close or flush.
- **Trace** consists of many operations. Trace defines all the operations, their order and timing.
- **Pass** is a series of traces executed, one at a time.
- **Phase** is a series of passes run one at a time.
- A **complete benchmark run** is a series of phases, one or more.

Scoring

PCMark 10 Storage Benchmarks produce an overall score, which is calculated from the bandwidth and average access time sub-scores.



Overall score

$$PCMark\ 10\ Storage\ score = geometric\ mean\left(bandwidth, \frac{1}{average\ access\ time}\right)$$

Sub-scores

The secondary metrics are *Bandwidth* and *Average access time.*

During a trace playback, the start and end time is measured for each I/O.

$$access\_time\_for\_an\_I/O = end\ time\ -\ start\ time$$

Specifically, filesystem target type can issue other types of I/O than read and write, for example *create file* and *close file*. To be able to focus on actual data transfer performance:

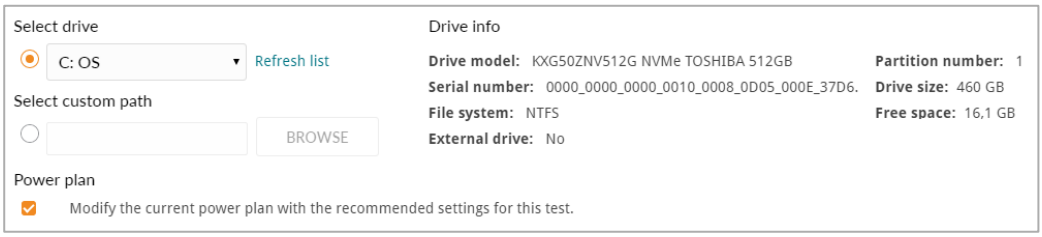
$$average\_access\_time = arithmetic\ mean\ of\ only\ read\ and\ write\ access\ time$$

Busy time is a metric used to quantify the amount of time that the storage device is executing I/Os. It is defined as the sum of all times when at least one I/O was executing. Again, to be able to focus on data transfer performance, we define *busy_time_for_read_and_write* as the time when at least one read or write operation was executing. Using this and the number of bytes being transferred during the trace playback, we define:

$$bandwidth = bytes\ /\ busy\_time\_for\_read\_and\_write$$

SETTINGS

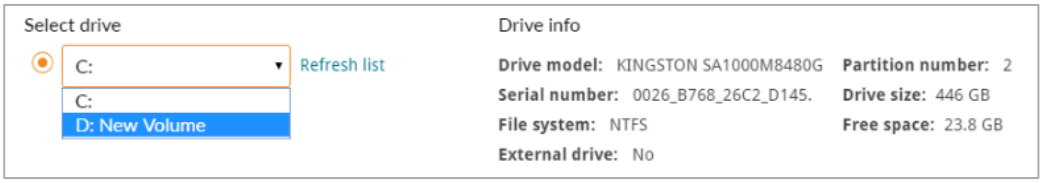
All four Storage Benchmarks include a set of settings. You can change these settings before the start of the tests.



Select drive

Select the drive you want to benchmark from the dropdown menu. Note that you need to hit the *Refresh list* if you plug in an external drive to see all the drives in the list.

The *Drive info* displays the information of the selected drive.



Select custom path

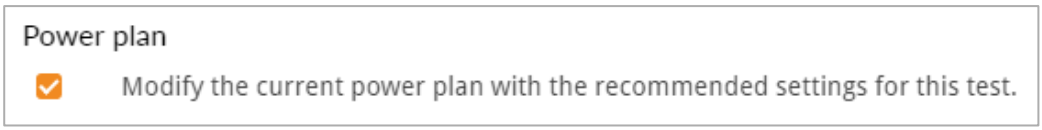
The *custom path* allows you to benchmark a specific folder. For example, you can select to benchmark a network shared folder.

Power plan

There is a considerable difference between the storage performance with Balanced and High Performance power profiles. Disabling C-states in BIOS can improve the performance even higher. The solution is that we customize the power scheme for the benchmark.

The *power plan* setting enables the temporary custom power plan that we create and use to be able to disable CPU down-throttling. This setting is enabled by default. Turn off the power plan setting to disable the use of the custom power plan.

We recommend running the benchmark with the power plan setting enabled.



The custom power scheme is used during the benchmark with the following procedure:

1. The benchmark creates a new power scheme by duplicating the current one.
2. The custom power scheme is modified by changing the following settings:
    a. GUID_PROCESSOR_THROTTLE_MAXIMUM is set to 100
    b. GUID_PROCESSOR_THROTTLE_MINIMUM is set to 100
    c. GUID_PROCESSOR_IDLE_DEMOTE_THRESHOLD is set to 100
    d. GUID_PROCESSOR_IDLE_PROMOTE_THRESHOLD is set to 100
3. When the timed part of the benchmark is about to run the custom profile is made active and a 100ms period is waited before proceeding.
4. Once a timed part is finished, the default scheme is made active. The goal is to let the system cool down.
5. Steps 3 and 4 are repeated for all traces, passes and phases.
6. At the end of the benchmark, the default power scheme is made active and the custom scheme is deleted.

FULL SYSTEM DRIVE BENCHMARK

The PCMark 10 Full System Drive Benchmark uses a wide-ranging set of real-world traces from popular applications and common tasks to fully test the performance of the fastest modern drives.

The benchmark is designed to measure performance of fast system drives using the SATA bus at the low end and devices connected via PCI Express at the high end. The goal of the benchmark is to show meaningful real-world performance differences between fast storage technologies such as SATA, NVMe, and Intel's Optane.

The Full System Drive Benchmark uses all 23 traces, running 3 passes with each trace. It typically takes an hour to run.

Traces used

RESULT FILE LABEL	DESCRIPTION
boo	Booting Windows 10
sacr	Adobe Acrobat - starting the application until usable
saft	Adobe After Effects - starting the application until usable
sill	Adobe Illustrator - starting the application until usable
spre	Adobe Premiere Pro - starting the application until usable
slig	Adobe Lightroom - starting the application until usable
sps	Adobe Photoshop - starting the application until usable
bf	Battlefield V - starting the game until the main menu
cod	Call of Duty Black Ops 4 - starting the game until the main menu
ow	Overwatch - starting the game until main menu
aft	Using Adobe After Effects

RESULT FILE LABEL	DESCRIPTION
exc	Using Microsoft Excel
ill	Using Adobe Illustrator
ind	Using Adobe InDesign
pow	Using Microsoft PowerPoint
psh	Using Adobe Photoshop (heavy use)
psl	Using Adobe Photoshop (light use)
cp1	Copying 4 ISO image files, 20 GB in total, from a secondary drive to the target drive (write test)
cp2	Making a copy of the ISO files (read-write test)
cp3	Copying the ISO to a secondary drive (read test)
cps1	Copying 339 JPEG files, 2.37 GB in total, to the target drive (write test)
cps2	Making a copy of the JPEG files (read-write test)
cps3	Copying the JPEG files to another drive (read test)

QUICK SYSTEM DRIVE BENCHMARK

The Quick System Drive Benchmark is a shorter test with a smaller set of less demanding real-world traces. You can use this benchmark to test smaller system drives that are unable to run the Full System Drive benchmark. This benchmark is better suited for testing entry performance level and lower capacity drives in less demanding use scenarios.

The benchmark is designed to measure the performance of small system drives from traditional spinning drives (HDDs) at the low end and entry-level PCI Express SSDs at the high end.

The Quick System Drive Benchmark uses 6 traces, running 3 passes with each trace. It typically takes 20 minutes to run.

Traces used

RESULT FILE LABEL	DESCRIPTION
cps1	Copying 339 JPEG files, 2.37 GB in total, in to the target drive (write test)
cps2	Making a copy of the JPEG files (read-write test)
cps3	Copying the JPEG files to another drive (read test)
exc	Using Microsoft Excel
ill	Using Adobe Illustrator
psl	Using Adobe Photoshop (light use)

DATA DRIVE BENCHMARK

The Data Drive Benchmark is designed to test drives that are used for storing files rather than applications. You can also use this test with NAS drives, USB sticks, memory cards, and other external storage devices.

The Data Drive Benchmark uses 3 traces, running 3 passes with each trace. It typically takes 15 minutes to run, but this can vary due to wide differences in performance across devices, for example, USB sticks.

Traces used

RESULT FILE LABEL	DESCRIPTION
cps1	Copying 339 JPEG files, 2.37 GB in total, in to the target drive (write test)
cps2	Making a copy of the JPEG files (read-write test)
cps3	Copying the JPEG files to another drive (read test)

DRIVE PERFORMANCE CONSISTENCY TEST

The Drive Performance Consistency Test is a long-running and extremely demanding test with a heavy, continuous load for expert users.

The test includes a degradation phase, a steady state phase, and a recovery phase. In-depth reporting shows how the performance of the drive varies under these conditions.

The typical run time is 10 to 20 hours.

⚠ The expected useful life of some storage devices is based on the number of write-erase cycles they perform. Running this benchmark repeatedly will significantly shorten the life time of some drives.

Traces used

RESULT FILE LABEL	DESCRIPTION
aft	Using Adobe After Effects
ind	Using Adobe InDesign
psh	Using Adobe Photoshop (heavy use)
cp1	Copying 4 ISO image files, 20 GB in total, from an secondary drive to the target drive (write test)
cp2	Making a copy of the ISO files (read-write test)
cps1	Copying 339 JPEG files, 2.37 GB in total, in to the target drive (write test)
cps2	Making a copy of the JPEG files (read-write test)

These traces are included in metrics.csv included in the result zip file.

Test method

The general approach of the Drive Performance Consistency Test is defined by five phases:

1. Precondition phase
2. Degradation phase
3. Steady state phase
4. Recovery phase
5. Clean up phase

All the benchmarking I/Os are performed only on the files created by the benchmark. User data on the drive is not touched by the test.

Precondition phase

To prepare the drive for testing, it is filled almost completely with temporary files.

1. Write the drive sequentially up to the reported capacity with random data, write size of 256 × 512 = 131,072 bytes. See setting precondition_block_size.
2. Write it through a second time, to take care of overprovisioning. See setting precondition_passes.

Degradation phase

The aim of the degradation phase is to overwhelm the drive with write operations so that it is not able to perform its general housekeeping and optimization routines. As the name implies, the performance of the drive is expected to degrade during this phase.

1. Run writes of random size between 8 × 512 and 2048 × 512 bytes on random offsets for 1 minute or until 50 GB has been written, whichever comes first. See settings degrade_duration_init, degrade_data_size_init, degrade_min_block_size, degrade_alignment, degrade_max_block_size.
2. Run a performance test with one trace.
3. Repeat steps 1 and 2 with each trace. For each repetition, we increase the duration of random writes in step 1 by 1 minute or 50 GB. See settings degrade_duration_increment and degrade_data_size_increment.
4. Repeat steps 1-3 for 8 passes. See setting degrade_passes.

Steady state phase

In the steady state phase, the last and most demanding pass of degradation phase is repeated a couple of times.

1. Run writes of random size on random offsets (as in degradation step 1) for the final duration and data size achieved in degradation phase.
2. Run a performance test with one trace.
3. Repeat steps 1 and 2 with each trace.
4. Repeat steps 1-3 three times. See setting steady_passes.

Recovery phase

The aim of the recovery phase is to see how quickly the drive is able to recover and optimize its performance.

1. Idle for 5 minutes. See setting recovery_duration_init.
2. Run a performance test with all traces.
3. Repeat steps 1 and 2 five times. See setting recovery_passes. With the recovery_duration_increment setting you can optionally increase the idle time for each repetition. The default is no increase.

Clean up

This phase removes the temporary test data from the drive. User data on the drive is left untouched.

1. Write the drive sequentially through up to the reported capacity with zero data, write size of 256 × 512 = 131,072 bytes. See settings postcondition_passes, postcondition_block_size.

Scoring

The overall score of the Drive Performance Consistency Test score is the performance score from the steady state phase. It represents the worst-case scenario for the drive's performance.

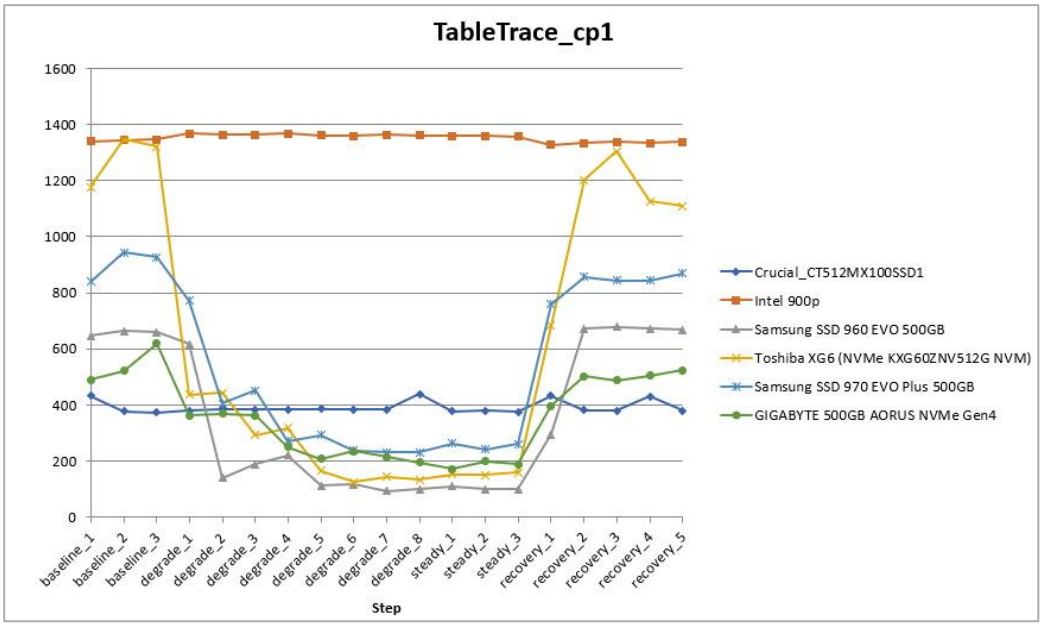
The final result from the recovery phase can be considered the best-case scenario for the drive's performance.

Export result data to Microsoft Excel

The Drive Performance Consistency Test generates a large amount of result data that is not shown on the in-app result screen. You can export the result data as an Excel file.

1. Load the result on the Results screen in the PCMark 10 app.
2. Click on the OPTIONS button
3. Select "Save as -> Excel

The exported Excel file contains graphs that provide insights into the performance of the drive during each phase. In the graph below, data from several devices have been exported. This graph shows the performance during the cp1 trace. The points of phases are displayed on the x-axis of the graph.



The Excel file contains one sheet for every storage result included in the export. This sheet contains the data from pcmark_storage_trace_metrics.csv and pcmark_storage_trace_statistics.csv converted to separate tables.

The Excel file contains two additional summary sheets named *Trace* and *Aggregated*. The different tables on these summary sheets are for the different traces aft, cp1, psh and others. Each column in these tables shows data from a correspondingly named sheet. Formulas are used to reference data from the data sheets.

You can configure the metrics data shown in the tables and graphs using the pulldown menu in cell B1. Examples of values to show are rw_bw and rw_aat.

RESULT DATA IN DETAIL

PCMark 10 Storage Benchmarks produce large amounts of detailed result data that is not shown on the in-app result screen. You can export this result data as an Excel file for in-depth analysis.

1. Load the result on the Results screen in the PCMark 10 app.
2. Click on the OPTIONS button
3. Select “Save as -> Excel

The exported Excel file contains the raw data as well as prebuilt tables and charts with various filters and options that let you choose how to view the data.

Output files

The Storage benchmarks and Drive Performance Consistency Test produce two output files that are included in the result file. Result files are usually saved in your Documents folder, and can be opened with any ZIP program.

- pcmark_storage_trace_statistics.csv
- pcmark_storage_trace_metrics.csv.

The first file lists statistics for each trace used in the benchmark. They do not change run to run if the selection of traces is the same.

The second file lists various metrics for each playback of a trace and cumulative aggregated metrics. The data from these files can be exported from PCMark 10 to an Excel file.

Additional output files can be generated by using the dump_output setting with value the true in the Command Line definition file. With this setting, a file for each trace playback is produced listing the measured timing for every single I/O executed during the playback.

Trace statistics

The variables in the table below provide basic information on each trace. The statistics remain constant from run to run when the benchmark is run with the same settings.

Statistics can be found in the pcmark_storage_trace_statistics.csv output file.

	UNIT	DESCRIPTION
bytes_read	bytes	Number of bytes read

	UNIT	DESCRIPTION
bytes_write	bytes	Number of bytes written
bytes_read_aligned	bytes	Number of bytes read after alignment to the target drive
bytes_write_aligned	bytes	Number of bytes read after alignment to the target drive
reads		Number of read operations
writes		Number of write operations
createfiles		Number of CreateFile operations (in the file system level)
closefiles		Number of CloseFile operations (in the file system level)
flushes		Number of flushes
idle_periods		Number of idle periods
idle	µs	The sum of all idle times
idle_compressed	µs	The sum of idle times after the idle time compression
busy	µs	The sum of all busy times
access	µs	The sum of all access times

	UNIT	DESCRIPTION
compressed_playback_time	ms	The playback time with idle times compressed (= busy + idle_compressed)
bandwidth	B/s	The bandwidth (= bytes moved / busy)
average_access	µs	The average access time (= access / the number of I/Os)
max_read_size	B	The largest read operation
max_write_size	B	The largest write operation
max_read_location		The largest read location
max_write_location		The largest write location
max_queue_depth		The largest queue depth

Metrics and filters

The benchmarks calculate several useful metrics. The metrics are calculated many times taking into account the varying set of operations. For example, bandwidth is calculated separately for read and write operations, for small or large operations, and for sequential and random operations. This allows users to select the most important metrics for their needs.

Calculated metrics are listed below. Possible prefix values (taking the place of <mf>) are listed later.

METRIC NAME	UNIT	DESCRIPTION
<mf>_count	-	The number of operations executed

METRIC NAME	UNIT	DESCRIPTION
<mf>_bytes	B	The number of bytes transferred.
<mf>_busy	µs	The total busy time during the playback
<mf>_notbusy	µs	The total time being not busy during the playback[9]
<mf>_dc	1/1000	The duty cycle calculated as the ratio of busy and notbusy in permilles.
<mf>_bw	B/s	The bandwidth (= bytes moved / busy)
<mf>_aat	µs	The average access time (= total access / the number of I/Os)
<mf>_at50	µs	The 50% percentile of access times
<mf>_at90	µs	The 90% percentile of access times
<mf>_at90	µs	The 95% percentile of access times
<mf>_at99	µs	The 99% percentile of access times
<mf>_at9999	µs	The 99.99% percentile of access times

Metric filters (<mf>) available are listed in the table below.

[9] Usually called "idle", in this case "notbusy", reminds that the storage device may not be idling but executing some other operations. This metric focuses on some operation types ignoring the rest. Total playback time can be calculated with busy and not busy times as: <total_playback time> = busy time + not busy time.

METRICS FILTER	DESCRIPTION
all	All operations
rw	Read and write operations
read	Read operations
write	Write operations
read_s, write_s	Small size read / write operations with the data size up to 16k (inclusive)
read_m, write_m	Medium size read / write operations with the data size between 16k (exclusive) and 128k (inclusive)
read_l, write_m	Large read / write operations with the data size larger than 128k (exclusive)
read_s_rnd, write_s_rnd	Small random read / write operations
read_seq, write_seq	Sequential read / write operations. Operation is considered sequential if it starts from the offset that continues from where the last operation finished, otherwise it is random.
create	Create file operations
close	Close file operations
flush	Flush operations

Trace metrics

Trace metrics are calculated for each playback of a trace. Trace metrics can be found in the pcmark_storage_trace_metrics.csv output file with column type having the value trace. Column trace specifies the trace (refer to the table listing of the traces).

Aggregated metrics

Aggregated metrics are estimates calculated from all the trace metrics. The values reported are the geometric mean over samples for rate values. For counts (bytes and times) the aggregation function is the sum of the values.

Aggregated metrics are in the pcmark_storage_trace_metrics.csv output file with column type having the value aggregated.

The column trace specifies the trace with one special item: trace all_traces is an average over all the trace results in the pass.

Two multi-pass metrics, rw_bw and rw_aat, are reported as the secondary metrics. They can be found in the ArieI.xml data file in the result file.

HOW TO REPORT SCORES

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.

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

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RELEASE NOTES

PCMark 10 v2.1.2508 – February 11, 2021

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

Fixed

- Minor localization update on the Results screen.

Professional Edition only

- Fixed an issue with the Applications benchmark that could produce an infinite score in the Microsoft Edge test.
- Fixed the issue with the Applications benchmark getting stuck in the save dialogue during the Microsoft Word test.

PCMark 10 v2.1.2506 – September 10, 2020

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

Professional Edition only

- The PCMark 10 Video Battery Life test is now compatible with the latest version of the Microsoft Movies & TV (U.S.) and Microsoft Film & TV (ROW) applications.
- Fixed an issue that could cause the Microsoft Word test in the PCMark 10 Applications benchmark to fail with a "command not available" error.

PCMark 10 v2.1.2177 – February 20, 2020

This update adds German, Russian, and Simplified Chinese language options to the PCMark 10 Storage benchmarks. You can change the language on the Options screen. Benchmark scores are not affected.

New

- The PCMark 10 Storage benchmarks are now available in German, Russian, and Simplified Chinese alongside English.

Compatibility

- The PCMark 10 Applications benchmark is now compatible with the current version (80.0.361.54) of the Chromium-based Microsoft Edge browser.

Fixed

- Temporary files and power profiles created by the Storage benchmarks are now cleaned up in case there is a test crash.
- The PCMark 10 app will prompt a SystemInfo update on systems that do not have it installed.
- Minor UI fixes.

PCMark 10 v2.1.2165 – February 6, 2020

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

Compatibility

- The PCMark 10 Applications benchmark is now compatible with the new Chromium-based Microsoft Edge browser.
- Improved compatibility with the Windows 10 Background Activity Moderator service to avoid PCMark 10 tests being classed as background processes.

PCMark 10 v2.1.2153 – December 11, 2019

This is a major update that adds new benchmarks for testing the performance of the latest PC storage devices. Scores from other PCMark 10 benchmark tests are not affected.

New in PCMark 10 Professional Edition

- PCMark 10 Full System Drive Benchmark
- PCMark 10 Quick System Drive Benchmark
- PCMark 10 Data Drive Benchmark
- PCMark 10 Drive Performance Consistency Test.

PCMark 10 v2.0.2144 – October 7, 2019

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

Compatibility

- You can now force every test to run on Arm-powered devices from the command line. Some workloads are not compatible with Arm devices, which means you will not get an overall score from some benchmarks.

Fixed

- Bug fixes in the Battery Life, Spreadsheets, and App Startup tests to improve stability.

PCMark 10 v2.0.2115 – June 6, 2019

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

Fixed

- Updated the OpenCV library used in the Video Conferencing test to conform to the OpenCV specification.

Compatibility

- The Rendering and Visualization test no longer fails when the Windows input language is Chinese or Korean.
- The Video Battery Life test no longer fails when the Windows operating system language is Slovak.

PCMark 10 v2.0.2106 - May 27, 2019

This is a major update that adds new benchmark tests and features. Benchmark scores are not affected.

New in PCMark 10 Professional Edition

Discover a new approach to battery life testing with the PCMark 10 Battery Life Profile. Test and compare battery life across five common scenarios.

- PCMark 10 Modern Office Battery Life test
- PCMark 10 Applications Battery Life test
- PCMark 10 Video Battery Life test
- PCMark 10 Gaming Battery Life test
- PCMark 10 Idle Battery Life test

Measure practical, real-world PC performance with the PCMark 10 Applications benchmark. New tests based on popular Microsoft applications.

- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint
- Microsoft Edge

Improved

- Redesigned the Benchmarks and Results screens to support new tests.
- You can now view and manage your benchmark results on the Results screen.
- You can now compare up to four results side by side in the app.

PCMark 10 v2.0.2091 - May 13, 2019

Released as preview to select press publications.

New

- Added PCMark 10 Battery Life Profile tests:
    - PCMark 10 Modern Office Battery Life test
    - PCMark 10 Applications Battery Life test
    - PCMark 10 Video Battery Life test
    - PCMark 10 Gaming Battery Life test
    - PCMark 10 Idle Battery Life test
- Added new PCMark 10 Applications benchmark test.

Improved

- New design for the Benchmarks and Results screens.
- The Results screen now shows a history of your results.
- You can now compare up to four results side by side in the app.

PCMark 10 v1.1.1761 – April 1, 2019

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

Improved

- License key check is no longer case-sensitive.
- PCMark 10 will now warn and prevent you from installing to a path that contains non-Latin-alphabet characters.

Fixed

- Fixed an OpenCL device selection issue when using custom benchmark settings.
- Added a workaround for a bug in Windows 10 (1809) that causes the Rendering and Visualization test to crash if the Windows input method is set to a non-Latin language.
- Fixed an issue that prevented PCMark 10 from saving result files to a network drive.

PCMark 10 v1.1.1739 – July 5, 2018

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

Fixed

- Benchmarks no longer crash if SystemInfo should fail to run.
- Fixed a bug in the application update service.

Users with v1.1.1722 should download and install this update manually.

PCMark 10 v1.1.1722 – June 20, 2018

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

Improved

- SystemInfo module updated to 5.10 for improved compatibility with the latest hardware.
- Result details now include the Total Available Video Memory for the system.
- Improved update notification system.
- Text, logos, links, and file paths updated to reflect new company branding. See https://benchmarks.ul.com/welcome.

Fixed

- Fixed an issue with logging that could cause a benchmark run to fail.

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 UL 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 UL from the source code at http://www.imagemagick.org/download/windows/

OpenCV v3.1.0

- Built by UL from the source code at https://github.com/ltseez/opencv/
- Added the following patch to conform to OpenCV standards: https://github.com/opencv/opencv/commit/8c66531c42c5c37ae2647a96f84e13abe2119e02

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 UL 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 UL from the source code at https://github.com/POV-Ray/povray/commit/ea3d549a0c27c0dfb5c51e9fcd980866cfaf654b.
- The changes made by UL 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, Applications benchmark, and Modern Office performance score.

- 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

Laptop (Modern Office reference PC)

- 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

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 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 teams in California, China, Taiwan, and Germany.

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