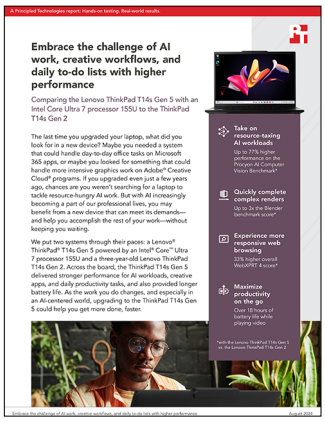

The science behind the report:

Meet the demands of today and tomorrow with a faster laptop for AI, creative, and everyday work

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report Meet the demands of today and tomorrow with a faster laptop for AI, creative, and everyday work.

We concluded our hands-on testing on July 3, 2024. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on July 3, 2024 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

To learn more about how we have calculated the wins in this report, go to http://facts.pt/calculating-and-highlighting-wins. Unless we state otherwise, we have followed the rules and principles we outline in that document.

AI performance benchmarks and tools

Procyon® AI Computer Vision

Table 1: Our Procyon AI Computer Vision benchmark results. Higher overall scores and inference counts are better. Lower inference times are better. We report the median results of three runs for each test.

Intel® OpenVINO™	ThinkPad® T14s Gen 5	ThinkPad T14s Gen 2
Float32 (seconds)	GPU	GPU
Overall score	**114**	**136**
DeepLab V3 average inference time	34.123	35.915
DeepLab V3 median inference time	34.358	35.885
DeepLab V3 inferences count	4,354	4,433
ESRGAN average inference time	2,636.473	2,180.177
ESRGAN median inference time	2,674.573	2,148.13
ESRGAN inferences count	69	83
Inception V4 average inference time	34.492	28.442
Inception V4 median inference time	34.6	28.188
Inception V4 inferences count	4,855	6,003
MobileNet V3 average inference time	2.427	1.618

Intel® OpenVINO™	ThinkPad® T14s Gen 5	ThinkPad T14s Gen 2
MobileNet V3 median inference time	2.369	1.598
MobileNet V3 inferences count	60,139	95,188
ResNet 50 average inference time	12.003	9.702
ResNet 50 median inference time	11.992	9.697
ResNet 50 inferences count	13,896	17,903
YOLO V3 average inference time	75.343	70.021
YOLO V3 median inference time	73.391	68.785
YOLO V3 inferences count	2,228	2,461
Float16 (seconds)	NPU	GPU
Overall score	**192**	**327**
DeepLab V3 average inference time	21.463	40.153
DeepLab V3 median inference time	21.381	40.141
DeepLab V3 inferences count	6,321	3,981
ESRGAN average inference time	1,237.719	558
ESRGAN median inference time	1,227.282	557.972
ESRGAN inferences count	146	322
Inception V4 average inference time	22.238	10.877
Inception V4 median inference time	22.166	10.813
Inception V4 inferences count	7,235	14,484
MobileNet V3 average inference time	1.881	0.862
MobileNet V3 median inference time	1.832	0.852
MobileNet V3 inferences count	75,388	151,110
ResNet 50 average inference time	6.739	3.217
ResNet 50 median inference time	6.601	3.189
ResNet 50 inferences count	23,755	48,500
YOLO V3 average inference time	41.293	18.897
YOLO V3 median inference time	40.976	18.957
YOLO V3 inferences count	3,838	8,222
Int8 (seconds)	NPU	GPU
Overall score	**318**	**565**
DeepLab V3 average inference time	11.575	22.624
DeepLab V3 median inference time	11.484	22.403
DeepLab V3 inferences count	9,851	6,638
ESRGAN average inference time	774.075	308.316
ESRGAN median inference time	761.746	308.199
ESRGAN inferences count	233	582
Inception V4 average inference time	11.889	6.265
Inception V4 median inference time	11.824	6.197
Inception V4 inferences count	12659	23546
MobileNet V3 average inference time	1.639	0.685
MobileNet V3 median inference time	1.587	0.662
MobileNet V3 inferences count	84,873	191,939

Intel® OpenVINO™	ThinkPad® T14s Gen 5	ThinkPad T14s Gen 2
ResNet-50 average inference time	4.39	1.688
ResNet-50 median inference time	4.325	1.681
ResNet-50 inferences count	35,420	84,596
YOLO V3 average inference time	19.539	9.439
YOLO V3 median inference time	19.973	9.407
YOLO V3 inferences count	7,442	15,067

Topaz Video AI

Table 2: Our Topaz AI benchmark results. Higher benchmark scores are better. We report the median score of three runs for each test.

	ThinkPad T14s Gen 5	ThinkPad T14s Gen 2
AI 5.10 FHD		
FHD Artemis 1X	1.05	NA**
FHD Artemis 2X	0.69	NA**
FHD Artemis 4X	NA*	NA**
FHD Iris 1X	1.01	NA**
FHD Iris 2X	0.61	NA**
FHD Iris 4X	0.17	NA**
FHD Proteus 1X	0.79	NA**
FHD Proteus 2X	0.65	NA**
FHD Proteus 4X	0.29	NA**
FHD Gaia 1X	0.30	NA**
FHD Gaia 2X	0.26	NA**
FHD Gaia 4X	0.18	NA**
FHD Nyx 1X	0.22	NA**
FHD Nyx 2X	0.40	NA**
FHD Nyx Fast 1X	0.54	NA**
FHD 4X Slowmo Apollo	0.89	NA**
FHD APFast	4.14	NA**
FHD Chronos	0.50	NA**
FHD CHFast	0.88	NA**
FHD Aion 16X	NA*	NA**
AI 5.10 4K		
4K Artemis 1X	0.21	NA**
4K Artemis 2X	NA*	NA**
4K Artemis 4X	NA*	NA**
4K Iris 1X	0.18	NA**
4K Iris 2X	0.11	NA**
4K Iris 4X	0.03	NA**
4K Proteus 1X	0.19	NA**
4K Proteus 2X	0.12	NA**

	ThinkPad T14s Gen 5	ThinkPad T14s Gen 2
4K Proteus 4X	0.04	NA**
4K Gaia 1X	0.07	NA**
4K Gaia 2X	0.05	NA**
4K Gaia 4X	0.03	NA**
4K Nyx 1X	0.06	NA**
4K Nyx 2X	0.08	NA**
4K Nyx Fast 1X	0.16	NA**
4K 4X Slowmo Apollo	0.21	NA**
4K APFast	0.98	NA**
4K Chronos	0.11	NA**
4K CHFast	0.22	NA**
4K Aion 16X	NA*	NA**

*The Lenovo ThinkPad T14s Gen 5 consistently failed this test.
**We could not run Topaz Video AI on the Lenovo ThinkPad T14s Gen 2.

Graphics-intensive performance benchmarks and tools

Table 3: Our graphics-intensive benchmark results. Higher benchmark scores, samples per minute, and FPS are better. Less time (mm:ss) is better. We report the median results of three runs for each test.

	ThinkPad T14s Gen 5	ThinkPad T14s Gen 2
3DMark® overall scores		
Fire Strike	5,065	4,351
Time Spy	1,964	1,673
Blender samples per minute		
Monster	108.07	33.17
Junkshop	30.74	22.37
Classroom	47.28	16.22
Cinebench 2024 scores		
Multi-core	441	189
Single core	100	64
Handbrake Fast 1080p30 preset test		
Encode time (mm:ss)	4:05	6:25
Average encoding FPS	30.05	19.05
Handbrake 4K H.265 endcoder test		
Encode time (mm:ss)	5:35	8:00
Average encoding FPS	21.84	15.24
Procyon Photo Benchmark using Adobe Photoshop		
Overall score	4,410	3,881
Procyon Video Benchmark using Adobe Premiere Pro		
Overall score	2,294	1,667
PugetBench (Overall score, higher is better)		
Adobe® Photoshop®	5,065	4,271
Adobe Premiere® Pro	2,184	1,915

General performance benchmarks

Table 4: Our general performance benchmark results. Higher benchmark scores and ratings are better. We report the median results of three runs for each test.

	ThinkPad T14s Gen 5	ThinkPad T14s Gen 2
CrossMark™		
Overall score	**1,474**	**1,136**
Subscores		
Productivity	1,402	1,160
Creativity	1,666	1,151
Responsiveness	1,185	1,028
PassMark Performance Test 11		
Overall PassMark rating	**4,767**	**3,939**
CPU Mark score	18,188	9,536
2D Graphics Mark score	657	464
3D Graphics Mark score	3,477	3,483
Memory Mark score	2,542	2,309
Disk Mark score	37,697	20,099
SYSmark® 30		
Overall rating	**1,507**	**1,256**
Office Applications	1,414	984
General Productivity	1,434	1,316
Photo Editing	1,431	1,207
Advanced Content Creation	1,776	1,594
Procyon Office Productivity Benchmark		
Procyon Office Productivity overall rating	**6,118**	**5,063**
Word score	6,583	6,179
Excel score	6,054	4,820
PowerPoint score	6,384	5,432
Outlook score	4,960	3,261
WebXPRT 4 on Google Chrome v116.0.5845.140		
Overall score	**288**	**216**
Subscores (milliseconds, lower is better)		
Photo enhancement	292	309
Organize album using AI	1,240	2,018
Stock option pricing	76	105
Encrypt notes and OCR scan using WASM	752	1,038
Sales graphs	200	255
Online homework	1,634	2,188

Battery life, workflow, and user experience tests

Table 5: The table below represents our battery life, workflow, and user experience results in detail. We report the median score of three runs for each test.

	ThinkPad T14s Gen 5	ThinkPad T14s Gen 2
Time to complete tasks in Microsoft Office (seconds, less time is better)		
Microsoft Office Word		
Launch	0.7	0.7
Open 90MB Word document	0.8	1.0
Perform word Find/Replace	1.0	1.5
Export to PDF	4.1	5.0
Microsoft Office Excel		
Launch	0.8	0.8
Open 92MB Excel spreadsheet containing macro	13.2	18.1
Open 650KB 10K row Excel spreadsheet	0.6	0.6
Insert 3-D 100 percent stacked column chart	16.6	26.8
Microsoft Office PowerPoint		
Launch	0.7	0.7
Start slide show	0.7	0.8
Export 180MB PPTX to PDF	6.2	8.1
Content creation tasks (seconds, less time is better)		
Adobe Lightroom® Classic		
Launch	7.8	9.6
Create photomerge panorama	52.1	66.7
Adobe Photoshop		
Launch	5.4	7.1
Image process 50 RAW .NEF file and save image to JPEG	88.7	114.3
Perform merge to HDR	22.1	27.5
Real-world workflows (seconds, less time is better)		
Creative workflow using Adobe Creative Cloud (Photoshop, Premiere Pro, and After Effects®)		
Total time	**517**	**593**
Photoshop workflow tasks to merge to HDR	310	355
Premiere Pro workflow tasks to export	114	133
After Effects workflow tasks to render file	92	104
Photogrammetry/3D modeling workflow using Agisoft Metashape Pro v2.1.1		
Total time	**27,494**	**38,948**
Align photos	298	325
Build point cloud	22,220	33,989
Build mesh	1,567	2,102
Build texture	3,409	2,533
Battery life (minutes, less time is better)		
Local video playback	1,089	287
Speaker volume (decibels, louder is better)		
Max output	63.7	61.3

	ThinkPad T14s Gen 5		ThinkPad T14s Gen 2	
Thermal performance				
CineBench 2024.1.0 - Sustained Performance score (average)				
Multi-core	411		208	
Single core	100		62	
Average temperature	°C	°F	°C	°F
Ambient room temperature	23.5	74.3	23.7	74.6
Skin temperature - keyboard deck	46.9	116.4	47.1	116.7
Skin temperature - underside of chassis	48.0	118.5	45.4	113.7
Delta temperature from room temperature	°C	°F	°C	°F
Skin temperature - keyboard deck	23.4	42.1	23.4	42.1
Skin temperature - underside of chassis	24.6	44.2	21.7	39.1

System configuration information

Table 6: Detailed information on the systems we tested.

System configuration information	Lenovo ThinkPad T14s Gen 5	Lenovo ThinkPad T14s Gen 1
Processor		
Vendor	Intel®	Intel
Model number	Core™ Ultra 7 Processor 155U	Core i7-1165G7
Core frequency (GHz)	• E-cores up to 3.80 • P-cores up to 4.80 • Low Power Efficient-cores up to 2.1	• 2.80 to 4.70
Number of cores	12	4
Logical processors	14	8
Memory module(s)		
Amount (GB)	16	16
Type	LPDDR5X	DDR4
Graphics		
Vendor	Intel	Intel
Model number	Intel Arc™ Graphics	Intel Iris Xe™ Graphics
Storage		
Amount (GB)	512	512
Type	SSD	SSD
Connectivity/expansion		
Wireless internet	Intel Wi-Fi® 6E (802.11ax)	Wi-Fi 6 (802.11ax)
Bluetooth	5.3	5.3
USB	2x Thunderbolt™ 4 ports 2x USB-A 3.2	2x Thunderbolt 4 ports 2x USB-A 3.2
Battery		
Type	Integrated Lithium-polymer	Integrated Lithium-polymer
Rated capacity (Whr)	58	57
Display		
Size (in.)	14”	14”
Resolution	1,920 x 1,200	1,920 x 1,080
Operating system		
Vendor	Microsoft	Microsoft
Name	Windows 11 Pro	Windows 10 Pro
Version	10.0.22631 Build 22631	10.0.19045 Build 19045

System configuration information	Lenovo ThinkPad T14s Gen 5	Lenovo ThinkPad T14s Gen 1
BIOS		
BIOS name and version	Lenovo N46ET14W	Lenovo N35ET47W
Dimensions		
Height (in)	0.67	0.66
Width (in)	12.3	12.89
Depth (in)	8.6	8.90
Weight (system) lbs.	2.92	3.24

How we tested

Setting up the system

Setting up and updating the OEM image

1. Boot the system.
2. Follow the on-screen instructions to complete installation, using the default selections when appropriate.
3. Set the Windows (plugged in) Power Mode to Best Performance.
4. Set Screen and Sleep options to Never:
   - Right-click the desktop, and select Display settings.
   - From the left column, select System.
   - Click Power & Battery.
   - For all power options listed under Screen and Sleep, select Never.
5. Disable User Account Control notifications:
   - Select Windows Start, type `UAC`, and press Enter.
   - Move the slider control to Never notify, and click OK.
6. Run Windows Update, and install all updates available.
7. Verify the date and time are correct, and synchronize the system clock with the time server.
8. Pause Automatic Windows Updates:
   - Click the Windows Start button.
   - Type `Windows Update settings` and press Enter.
   - From the Pause updates drop-down menu, select Pause for 5 weeks.

Performance benchmark testing

SYSmark 30

Avoiding antivirus software conflicts

SYSmark 30 is not compatible with any virus-scanning software, so we uninstalled any such software present on the notebook PCs before we installed the benchmark.

Avoiding pre-installed software conflicts

SYSmark 30 installs the following applications, which its test scripts employ:

Office Applications

1. Microsoft Excel 2021
2. Microsoft Outlook 2021
3. Microsoft PowerPoint 2021
4. Microsoft Word 2021

General Productivity

1. Adobe Acrobat® Pro DC
2. Audacity (v 2.3.2)
3. Corel WinZip 26.0
4. Google Chrome (v 106.0.5249.103)

Photo Editing

1. Adobe Lightroom® Classic CC (version 11)ag
2. Adobe Photoshop® CC (version 23)

Advanced Content Creation

1. Adobe Photoshop CC (version 23)
2. Adobe Premiere CC (version 22)

If any of these applications already exist on the system under test, they could cause problems with the benchmark due to software conflicts. To avoid any such issues, we uninstalled all conflicting pre-installed software applications—including different versions of any of the programs SYSmark 30 uses—before we installed the benchmark.

Using the SYSmark built-in configuration tool

This tool supports three levels of configuration:

1. Only makes changes that are REQUIRED for the benchmark to run.
2. Additionally, makes changes that are RECOMMENDED for repeatable results.
3. Additionally, makes OPTIONAL changes that help ensure best results.

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

- Level 1 - Required
  - Disables User Account Control (UAC)
  - Set DPI Scaling to 100%
  - Disables Low Battery Actions
  - Disables Network Proxies
  - Disables System Sleep and Hibernate
  - Disables Windows Update
  - Enable Windows Search
  - Disables the WinSAT service
- Level 2 - Recommended
  - Disables User Account Control
  - Set DPI Scaling to 100%
  - Disables Low Battery Actions
  - Disables Network Proxies
  - Disables System Sleep and Hibernate
  - Disables Windows Update
  - Enables Windows Search
  - Disable the WinSAT service
  - Create BAPCo power scheme
  - Set Power Plan Type to High Performance
  - Set CPU High Performance
  - Disables Disk Defrag
  - Disables Windows Error Reporting
  - Disables Windows Lock Screen
  - Disables Windows Pop-ups
  - Disables Screen Saver and Monitor Timeout
  - Disables Windows Sidebar/Gadgets
  - Disables Desktop Slideshow
  - Set Font Smoothing
  - Disables Windows Security Center
- Level 3 - Optional
  - Disables Hard Disk Timeout
  - Disables System Restore
  - Ignores Laptop Lid Close
  - Enables Dark Mode

We chose the official BAPCo "Run Benchmark" default as outlined in the BAPCo SYSmark 30 User Guide (bapco_sysmark30_user_guide_v1.0.pdf), which runs the benchmark using the Required and Recommended options.

Setting up the test

1. Default options.

Running the test

1. Boot the system.
2. Select Windows Start.
3. Type `cmd`, and press Ctrl+Shift+Enter.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
5. After the command completes, wait five minutes before running the test.
6. Launch SYSmark 30.

7. Click on the Settings Gear icon.
8. Verify that the iterations are set to the default 1.
9. Verify that Conditioning Run is enabled.
10. Enter a name for the benchmark run.
11. To return to the main menu, click the Back button.
12. Click Run Benchmark.
13. When the benchmark finishes, record the SYSmark 30 benchmark results.
14. Repeat steps 1 through 13 twice more, and record the median results

3DMark

Setting up the test

1. Download the 3Dmark from http://www.futuremark.com/benchmarks/3dmark/all.
2. Install 3DMark with the default options by double-clicking the 3DMark installer.exe file.
3. Launch 3DMark by double-clicking on the 3Dmark desktop icon. Enter the registration code, and click Register.
4. Exit 3DMark.

Running the test

1. Boot the system and wait 5 minutes before running the test.
2. Double-click the 3DMark desktop icon to launch the benchmark.
3. At the 3DMark Home screen, click the More Tests button.
4. Select the desired benchmark to run (i.e. Fire Strike or Time Spy).
5. Move the slider button to turn off the "Include Demo" feature.
6. Click Run.
7. When the benchmark run completes, record the results.
8. Perform steps 1 through 7 two more times for each benchmark, and report the median of the three runs.

PassMark Performance Test

Setting up the test

1. Install PassMark Performance Test.
2. Download PassMark Performance Test from https://www.passmark.com/products/Performancetest/download.php.
3. To begin the installation, press Install.
4. Select Accept to accept the license agreement and press Next.
5. After the installation is complete, deselect Launch Performance Test, and press Finish.
6. Setup is complete.

Running the test

1. Launch PassMark Performance Test by pressing the PassMark Performance Test icon.
2. Press Run Benchmark to start the benchmark.
3. When the test completes, record the results.
4. Repeat steps 1 through 4 two more times.
5. Report the median of the three runs.

Cinebench 2024 benchmark testing

Setting up the Cinebench 2024 test

Download and install Cinebench from https://www.maxon.net/en/downloads/cinebench-2024-downloads.

Running the Cinebench 2024 benchmark

1. Launch Cinebench.
2. Select File→Advanced benchmark.
3. Set the Minimum Test Duration to Off.
4. Select either CPU (Multi Core) or CPU (Single Core), and click Start.
5. Record the result.
6. Wait 15 minutes before re-running.
7. Repeat steps 1 through 6 two more times.

BAPCo CrossMark benchmark testing

Setting up the test

Download and install CrossMark from the Microsoft Store or Apple App Store.

Running the test

1. Launch CrossMark.
2. Click Settings.
3. For Number of Iterations, choose 1.
4. Enter a valid email address, and click Back.
5. Click Run Benchmark.
6. Record the result.
7. Repeat steps 1 though 6 two more times.

WebXPRT 4 benchmark testing (Google Chrome)

Running the test

1. Open the Web browser under test, and go to https://www.principledtechnologies.com/benchmarkxprt/webxprt/.
2. Click Run WebXPRT 4.
3. At the Ready to test your browser screen, click Continue.
4. Click Start.
5. When the test completes, record the results.
6. Click Run Again, and click Start to rerun WebXPRT. Record the results.
7. Repeat step 6 two more times.

Procyon Office Productivity Benchmark testing

Setting up the test

1. Download and install Procyon.
2. Open Procyon.
3. Click Office Productivity Benchmark.
4. Click Register.
5. Enter the license key for the Office Productivity Benchmark, and click Register.
6. Before running the benchmark, make sure to install a licensed version of Microsoft 365.

Running the test

1. Boot the system.
2. Launch Procyon.
3. Click Office Productivity Benchmark.
4. Click Run.
5. When the benchmark is complete, record the results.
6. Wait 15 minutes before rerunning the benchmark.
7. Repeat steps 3 through 6 twice more.

Procyon Photo Editing Benchmark testing

Setting up the test

1. Download and install Procyon.
2. Open Procyon.
3. Click Photo Editing Benchmark.
4. Click Register.
5. Enter the license key for the Photo Editing Benchmark, and click Register.
6. Before running the benchmarks, install licensed versions of Adobe Photoshop 22.0 or higher and Adobe Lightroom Classic 10.0 or higher.

Running the test

1. Boot the system.
2. Launch Procyon.
3. Click Photo Editing Benchmark.
4. Click Run.
5. When the benchmark is complete, record the results.
6. Wait 15 minutes before rerunning the benchmark.
7. Repeat steps 1 through 6 twice more.

Procyon Video Editing Benchmark testing

Setting up the test

1. Download and install Procyon.
2. Open Procyon.
3. Click Video Editing Benchmark.
4. Click Register.
5. Enter the license key for the Video Editing Benchmark, and click Register.
6. Before running the benchmark, install a licensed version of Adobe Premiere Pro v24.2 or higher.

Running the test

1. Boot the system.
2. Launch Procyon.
3. Click Video Editing Benchmark.
4. Click Run.
5. When the benchmark is complete, record the results.
6. Wait 15 minutes before rerunning the benchmark.
7. Repeat steps 1 through 6 twice more.

Procyon AI Computer Vision Benchmark testing

Setting up the test

1. Purchase and download the Procyon AI Computer Vision Benchmark from https://benchmarks.ul.com/procyon.
2. Install the Procyon benchmark.
3. Launch Procyon.
4. Select Settings and input the Procyon AI Computer Vision license key.
5. Close Procyon.

Running the test

1. Boot the system.
2. Launch Procyon.
3. Click select the AI Computer Vision test.
4. Click Run.
5. When the test is complete, record the results.
6. Wait 15 minutes before rerunning the benchmark.
7. Repeat steps 1 through 6 twice more

PugetBench for Creators Adobe Creative Cloud benchmark testing

Puget Systems Adobe CC benchmarks are designed to thoroughly test many of Adobe's most popular software packages using real world projects and workflows.

PugetBench for Creators for Premiere Pro testing

We used the following application:

- Adobe Premiere Pro
- PugetBench for Creators

Setting up the test

1. Launch Adobe Premiere Pro.
2. Click through the Tutorial pop-up tips.
3. Close Adobe Premiere Pro.
4. Purchase a PugetBench for Premiere Pro license from https://www.pugetsystems.com/pugetbench/creators/.
5. Click the Download PugetBench for Creators on Windows.
6. After the download completes, double-click the installation file to install PugetBench.
7. Enter the license key in the license field. Click Activate.
8. Click Download Assets.

Running the test

9. Boot the system.
10. Open PugetBench for Creators.
11. Select the Photoshop test on the left side of the app.
12. Click Start Test
13. When the benchmark finishes, record the overall score.
14. Close PugetBench for Creators, and restart the system under test.
15. Wait 30 minutes before Performing the next run.
16. Repeat steps 1 through 7 twice more, and record the median result.

PugetBench for Creators for Photoshop testing

We used the following application:

- Adobe Photoshop
- PugetBench for Creators

Setting up the test

1. Launch Adobe Photoshop.
2. Click through the Tutorial pop-up tips.
3. Close Adobe Photoshop.
4. Purchase and download the PugetBench for Photoshop license from https://www.pugetsystems.com/pugetbench/creators/.
5. Click the Download PugetBench for Creators on Window link.
6. After the download completes, double-click the installation file to install PugetBench.
7. Enter the license key in the license field. Click Activate.
8. Click Download Assets.

Running the test

9. Boot the system.
10. Open PugetBench for Creators.
11. Select the Photoshop test on the left side of the app.
12. Click Start Test.
13. When the benchmark finishes, record the overall score.
14. Close PugetBench for Creators, and restart the system under test.
15. Wait 30 minutes before Performing the next run.
16. Repeat steps 1 through 7 twice more, and record the median result.

Blender benchmark testing

Setting up the test

1. Download the Blender Benchmark from https://Opendata.blender.org/.

Running the test

1. Launch the Blender Benchmark.
2. At the Welcome screen, click Next.
3. Select Blender version 3.5.0 and click Next.
4. At the Benchmark Scenes screen, click Next.
5. At the Benchmark Device screen, select the GPU option, and click Start Benchmark.
6. Record the results.
7. Wait 15 minutes before Performing the next run.
8. Repeat steps 1 through 7 two more times.

HandBrake video encoding testing

Setting up the Fast 1080p30 preset and Hardware 4K H.265 encoder tests

1. Download HandBrake from https://handbrake.fr/downloads.php
2. Install HandBrake with default options.
3. Copy the 4K file to be transcoded to the test system.
4. Launch HandBrake.
5. Browse to the 4K source file, click Open.

Running the Fast 1080p30 preset test

1. Click the Chapters tab, uncheck the Create chapter markers box.
2. Click Start Encode.
3. When complete, click the Show Queue menu item to view the encoding statistics.
4. Repeat steps 1 through 3 two more times.

Hardware 4K H.265 encoder test

1. Click the Preset drop-down menu, and select H.265 MKV 2160p 60.
2. Change the Format to MP4.
3. On the Filters tab, set all to Off.
4. On the Video tab, change the Video Encoder to H.265.
5. Set the preset to Ultra-Fast.
6. On the Chapters tab, uncheck the Create chapter markers box.
7. Click Start.
8. When complete, click the Show Queue menu item to view the encoding statistics and record the results.
9. Repeat steps 1 through 8 two more times.

Topaz Video AI testing

Setting up the test

1. Purchase a Pro license and download and install Topaz Video AI 5.10 from https://www.topazlabs.com/downloads.

Running the test in 1,920x1,080 (FHD)

1. Launch Topaz AI.
2. Close the activation window.
3. Select Process→ Benchmark.
4. From the Input Resolution drop-down menu, select 1920x1080 (FHD).
5. Click Benchmark.
6. When the test completes, record the results.
7. Wait 15 minutes before retesting.
8. Repeat steps 1 through 7 two more times.

Running the test in 3,480x2,160 (4K)

1. Launch Topaz AI.
2. Close the activation window.
3. Select Process→ Benchmark.
4. from the Input Resolution drop-down menu, select 3840x2160 (4K).
5. Click Benchmark.
6. When the test completes, record the results.
7. Wait 15 minutes before retesting.
8. Repeat steps 1 through 7 two more times.

Cinebench 2024 thermal testing

Setting up the environmental heatmap test

1. Download and install Cinebench from https://www.maxon.net/en/downloads/cinebench-r23-downloads.

   • Note: A FLIR E6xt infrared camera is necessary for taking top and bottom skin temperatures.

Running the environmental heatmap test

1. Launch Cinebench.
2. Select File→Advanced benchmark.
3. Verify that the Minimum Test Duration is set to the default 10 minutes (Test Throttling).
4. Select CPU (Multi Core), and click Start.
5. Record the Performance results for the next five back-to-back 10-minute iterations, and at the end of each run, note the ambient room temperature and take a skin temperature photo with the FLIR E6xt infrared Camera of the top and bottom and report the hottest spots.

Hand-timed custom workflow testing and multitasking scenarios

Time to complete the hand-timed Adobe Lightroom Classic scenario

We recorded how long it took to use photo merge panorama to create a 45MP image.

A stopwatch is required for this test.

We used the following application:

• Adobe Lightroom Classic v10.2

Running the test

1. Simultaneously start the timer and launch Lightroom.
2. Stop the timer when Lightroom has loaded.
3. Click Import.
4. Select the test file directory, and click Import.
5. To select all the imported photos, press Ctrl + A/CMD + A.
6. Click Photo→Photo Merge→Panorama.
7. Check the box next to Fill Edges.
8. Simultaneously start the timer and click Merge.
9. Stop the timer when the progress bar in the top left corner disappears and record the result.
10. Repeat steps 1 through 9 four more times.

Time to complete the hand-timed Adobe Photoshop scenario

We recorded how long it took to launch Adobe Photoshop, process 50 RAW NEF images and convert to JPEG, use photo merge panorama to create a 45MP image, and use HDR Pro to merge five images to an HDR image.

A stopwatch is required for this test.

We used the following application:

• Adobe Photoshop v22.4.1

Running the test

1. Simultaneously start the timer and launch Photoshop.
2. Stop the timer when Photoshop has loaded.
3. Select File→Scripts→Image Processor.
4. Click the Select Folder button, and select the test file directory.
5. For JPEG Quality, select 10.
6. Simultaneously start the timer and click Run.
7. Stop the timer when the spinning circle disappears and record the result.
8. Select File→Automate→Merge to HDR Pro.
9. Browse to the directory where the images are located, select them, and click OK.
10. Simultaneously start the timer and click OK.
11. Stop the timer when the preview merged file appears.
12. Simultaneously start the timer and click Ok.
13. Stop the timer when the HDR image has been created and record the result.
14. Repeat steps 1 through 13 two more times.

Time to complete the hand-timed Microsoft PowerPoint scenario

We recorded how long it took to launch PowerPoint, Open a 180MB PowerPoint PPTX file, start a slideshow task, and Export a PPTX to PDF.

A stopwatch is required for this test.

We used the following application:

- Microsoft PowerPoint (Windows v16.0.17531.20120)

Running the test

1. Simultaneously start the timer and launch PowerPoint.
2. Stop the timer when PowerPoint has loaded.
3. Browse to where the test PowerPoint file is located.
4. Open the PowerPoint file.
5. Simultaneously start the timer and press F5 to start the slide show.
6. Stop the timer when the slide show starts to play.
7. Exit the slide show.
8. Click File→Export→Create PDF/XPS.
9. Simultaneously start the timer and click Publish.
10. Stop the timer when the PDF has been created and record the results.
11. Repeat steps 1 through 11 two more times.

Time to complete the hand-timed Microsoft Excel scenario

We recorded how long it took to launch Excel, Open a 92MB macro Excel XLSX file, Open a 650KB 10K row Excel XLSX and insert a 3D 100% stacked column chart into the 10K row spreadsheet.

A stopwatch is required for this test.

We used the following application:

- Microsoft Excel (Windows v 2404.17531.20120)

Running the test

1. Simultaneously start the timer and launch Excel.
2. Stop the timer when Excel has loaded.
3. Browse to where the test Excel macro file is located.
4. Simultaneously start the timer and Open the Excel macro file.
5. Stop the timer when the Excel file has loaded.
6. Close the macro test file.
7. Browse to where the test Excel 10K row file is located.
8. Simultaneously start the timer and Open the 10K row file.
9. Stop the timer when the Excel file has loaded.

10. Click Insert and select the drop-down menu next to the Insert Column or Bar Chart icon.
11. At the bottom of the drop-down menu, select More Column Charts.
12. Under the Column section, choose 3-D 100% Stacked Column.
13. Simultaneously start the timer and click Ok.
14. Stop the timer when the 3-D 100% Stacked Column Chart appears and record the result.
15. Repeat steps 1 through 14 two more times.

Time to complete the hand-timed Microsoft Word scenario

We recorded how long it took to launch Word, Open a 90MB Word DOCX file, Perform a find/replace task, and Export a DOCX file to PDF.

A stopwatch is required for this test.

We used the following application:

- Microsoft Word (Windows v2404.17531.20120)

Running the test

1. Simultaneously start the timer and launch Word.
2. Stop the timer when Word has loaded.
3. Locate the test Word file.
4. Simultaneously start the timer and Open the Word file.
5. Stop the timer when the Word document has fully loaded.
6. Press CTRL + H/Control + H to bring up the Find/Replace dialog box.
7. In the Find What field, type `I`
8. In the Replace With field, type `TEST`
9. Simultaneously start the timer and select Replace All.
10. Stop the timer when Word has replaced every I.
11. Click File→Export→Create PDF/XPS.
12. Simultaneously start the timer and click Publish.
13. Stop the timer when the Word has Exported the document to PDF.
14. Close the Word document. Do not save changes.
15. Repeat steps 1 through 14 two more times.

Time to complete the hand-timed Photogrammetry/3D modeling workflow

We recorded how long it took to complete a Photogrammetry/3D modeling workflow using Agisoft Metashape Pro. A stopwatch is required for this test.

Setting up the test

1. Download and install Metashape Pro from https://www.agisoft.com/downloads/installer/.

Running the workflow

1. Launch Metashape.
2. From the top menu, select Workflow→Add Photos, select all 148 workload photos, and click Open.
3. Click the Console tab at the bottom of the screen to help monitor the output processes.
4. Click Workflow→Align Photos.
5. Next to the Accuracy drop-down menu, select Highest.
6. Simultaneously start the stopwatch and click OK.
7. Stop the stopwatch when the progress bar disappears, and record the result.
8. Click Workflow→Build Point Cloud.
9. Next to the Quality drop-down menu, select Ultra High.
10. Under Advanced, next to the Depth filtering drop-down menu, select Aggressive.
11. Simultaneously start the stopwatch and click OK.
12. Stop the stopwatch when the progress bar disappears, and record the result.
13. Click Workflow→Build Mesh.
14. Next to the Quality drop-down menu, select Ultra High.
15. Under Advanced, next to the Depth filtering drop-down menu, select Aggressive.

16. Simultaneously start the stopwatch and click OK.
17. Stop the stopwatch when the progress bar disappears, and record the result.
18. Click Workflow→Build Texture.
19. Leave the default 8,192 texture size, and change the count from x1 to x4.
20. Simultaneously start the stopwatch and click OK.
21. Stop the stopwatch when the progress bar disappears, and record the result.
22. Wait 30 minutes before re-running.
23. Repeat steps 1 through 22 two more times.

Time to complete the hand-timed Adobe Creative Cloud workflow

We recorded how long it took to complete a multi-tasking scenario using multiple Adobe Creative Cloud applications (Photoshop, Premiere Pro, and After Effects) and tasks. Once we Open an application, it remains Open for the duration of the testing. A stopwatch is required for this test.

Setting up the test

1. Download and install the Adobe Creative Cloud application from https://creativecloud.adobe.com/.
2. Launch the Creative Cloud application and log in to download Adobe Photoshop, Adobe Premiere Pro, and Adobe After Effects.
3. Launch each application, and click through the Tutorial pop-up tips. Afterwards, close each application.

Running the workflow

1. Simultaneously start the timer and launch Photoshop.
2. Select File→Scripts→Image Processor.
3. Click the Select Folder button and select the test file directory of RAW images.
4. For JPEG Quality, select 10.
5. Click Run.
6. When all the RAW images have been converted into JPEGs, as indicated by spinning circle disappearing, move to the next step.
7. Select File→Automate→Photomerge
8. Browse to the directory where the images are located, select them, and click OK
9. Click OK.
10. When the panoramic picture appears, close the panoramic picture file, and click Yes to save the image.
11. From the Format drop-down menu, select Large Document Format, and click Save.
12. Select File→Automate→Merge to HDR Pro.
13. Browse to the directory where the five HDR images are located, select them, and click OK.
14. Click OK.
15. When the preview merged file appears, click OK.
16. Stop the timer when the HDR image has been created, and record the results.
17. Simultaneously start the timer and launch Adobe Premiere Pro.
18. Select Open Project, and select the test Premiere project file, and click Open.
19. To bring up the Export Media dialog, press Ctrl+M.
20. From the Format drop-down menu, choose HEVC (H.265).
21. Click Export.
22. When the Export has finished, stop the timer, and record the time.
23. Simultaneously start the timer and launch Adobe After Effects.
24. Select New Project.
25. Click Composition→New Composition, and enter a name.
26. To import the 4K video file, press Ctrl + I.
27. Drag the newly imported 4K file from the top left corner box down to the bottom "timeline box," and select the timeline box.
28. Click Effect→Generate→CC Threads.
29. Click File→Export→Add to Render Queue.
30. In the bottom area where it says Output to: Not specified, click to add a save directory.
31. Select a save location, and click Save.
32. Click Render.
33. When the Export has finished, stop the timer, and record the time.
34. Close all the Adobe applications.
35. Wait 30 minutes before re-running.
36. Repeat steps 1 through 35 two more times.

Time to complete the hand-timed Adobe Premiere task

We recorded how long it took to Export a 5K RED video file to H.264.

A stopwatch is required for this test.

We used the following application:

- Adobe Premiere Pro v22.4.0

Running the test

1. Launch Premiere.
2. Select New Project, name the project, and select the test media to import.
3. Click Create.
4. Press Ctrl + M to bring up the Export Media dialog.
5. From the Format drop-down menu, choose .MP4 and H.264.
6. Simultaneously start the timer and click Export.
7. Stop the timer when the file has been Exported.
8. Repeat steps 1 through 7 twice more.

Web-camera quality testing

1. Set each system brightness as close as possible to 200 nits without going below that level.
2. Using a Digital light meter (Dr.meter LX1330B), measure the room brightness.
3. For the Windows 11 system, open the Camera App. For macOS systems, open the Photo Booth App.
4. When positioned correctly, take a picture.

Audio quality testing

Note: We conducted testing in an audio room with an enclosed sound booth. In addition to the systems under test (SUT), we used one additional system, located in the audio room. We connected this system to the speaker in the sound booth.

Maximum speaker volume output

Setup

1. Load VLC on each of the 6 SUTs with the file comprising the sample song clip.
2. Place Cirrus SPL meter in the audio booth in the same location as the speaker from Test 1.

Testing

1. Place the SUT on the desk in the sound booth. Measure the angle of screen tilt to maintain consistency across all SUTs.
2. Play the sample song clip in VLC and document the maximum volume recorded on the Cirrus SPL meter. Measure SPL of all SUTs from the same distance and position.

Measuring battery life with a local video playback

Note: Performing this test requires the following items:

- A Gossen Mavolux 5032C USB luminance meter
- A 5-minute 1080p .MP4 (329 MB) test video
- Battery exe installed in Users directory to capture start and end times

Setting up the local video playback test

1. Turn on the systems.
2. Copy the .MP4 file to each system, and verify that the video player is set to loop the video.
3. Verify that the displays will remain on, and disable power saving options.
4. Right-click the desktop, and select Display settings.
5. Uncheck the box next to Change brightness automatically when lighting changes.
6. Select Battery:

7. Under Turn battery saver on automatically drop-down menu verify that the default 20% is set.
8. Uncheck the box next to Lower screen brightness while in battery saver.
9. Select Power & sleep:
10. Under the Screen heading, change both the On battery power, turn off option and the When plugged in, turn off after option to Never.
11. Under the Sleep heading change both the On battery power, turn off option and the When plugged in, turn off after option to Never.
12. Click Additional Power Settings.
13. Click Change Plan settings.
14. Click Change Advanced Power Settings.
15. Expand the Battery field:
16. Under Critical Battery Notifications choose Off.
17. Under Low Battery Notifications choose Off.
18. To bring up a white screen, Open a web browser, and type `about:blank` into the address bar.
19. Unplug the systems.
20. Allow the screens to warm up for 30 minutes.
21. Use the luminance meter to adjust each screen to a brightness as close as possible to 250 nits.
22. Right-click the desktop, and select Display settings.
23. Adjust the slider bar until the luminance meter reads 250 nits.

Running the local video playback test

1. Verify that the system's battery is fully charged.
2. Launch the test .MP4 video in full screen mode.
3. Start battery.exe to capture start and finish battery time in Users directory.
4. Unplug the system from power.
5. When all the systems have finished, restart system and go to Users directory and document start and end times for system.
6. Repeat steps 1 through 5 two more times.

Read the report at https://facts.pt/NI5FMjs

This project was commissioned by Lenovo.