



A Dell Latitude 7420 laptop powered by a four-core Intel Core i7-1185G7 vPro processor delivered longer battery life and better overall performance benchmark scores

than a Lenovo ThinkPad T14 Gen 2 laptop powered by an eight-core AMD Ryzen 7 PRO 5850U processor

We compared battery life and system performance on two 14-inch laptops: the Dell Latitude 7420 laptop powered by a four-core Intel® Core™ i7-1185G7 vPro® processor and the Lenovo® ThinkPad® T14 Gen 2 laptop powered by an eight-core AMD Ryzen™ 7 PRO 5850U processor.

For battery life and plugged-in and unplugged system performance metrics, we ran the MobileMark® 2018, SYSmark® 25, and CrossMark™ benchmarks. These industry-standard benchmarks reflect real-world business professional usage patterns.



Photo: Principled Technologies



Work unplugged for almost 10 and a half hours

based on MobileMark 2018 overall battery life results



Make the most of your unplugged time with 63% better system performance

based on SYSmark 25 unplugged overall performance rating

Dell Latitude 7420 laptop

This 14-inch premium Windows 10 Pro business laptop comes equipped with Dell Optimizer and you can configure it with your choice of 11th Gen Intel Core i5 or i7 vPro processors.¹ We tested the laptop, but it is also available as a 2-in-1.

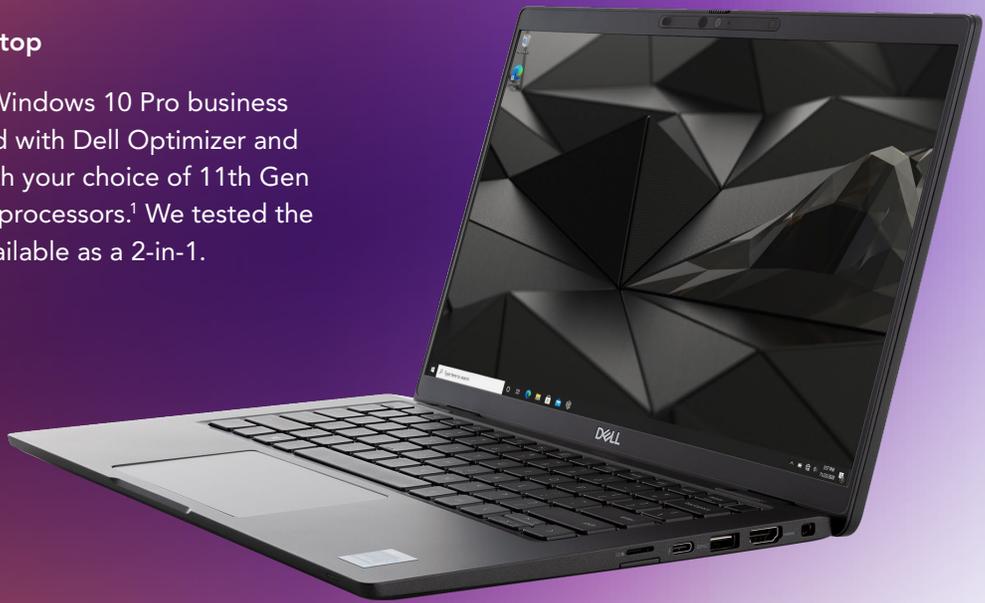


Photo: Principled Technologies

What we tested

We configured each Windows 10 Pro business laptop with 16 GB of memory and the largest capacity batteries available for each model. While the Dell laptop we tested had less storage, the tests we ran did not stress the storage. Before we started testing, we set both laptops to “best performance” power mode. During testing, we verified that both laptops stayed in “best performance” power mode for both plugged-in and on-battery tests. Other than making and verifying that one change, we used out-of-box OEM performance settings.

- **Dell Latitude 7420 laptop** powered by a four-core 11th Gen Intel Core i7-1185G7 vPro processor with Intel Iris® Xe Graphics, 256 GB of M.2 NVMe™ storage, and a four-cell 63-Whr ExpressCharge™ capable battery.
- **Lenovo ThinkPad T14 Gen 2 laptop** powered by an eight-core AMD Ryzen 7 PRO 5850U processor with AMD Radeon® Graphics, 512 GB of M.2 NVMe storage, and a three-cell 50-Whr battery with rapid-charge technology.

The MobileMark 2018, SYSmark 25, and CrossMark benchmarks put the laptops under test through scenarios based on the real-world applications and activities business users encounter every day.^{2,3,4} The battery life and performance qualification scores we report reflect the specific configurations we tested. Any difference in the configurations you test, as well as screen brightness, network traffic, or software additions, can affect these results. For a deeper dive into our testing parameters and procedures, see the [appendices](#).

Extended battery life without sacrificing performance

In our MobileMark 2018 benchmark comparison, both laptops delivered a full workday's worth of battery life. We also found that the Lenovo ThinkPad T14 Gen 2 laptop with its AMD Ryzen 7 PRO 5850U processor and 50-Whr battery had higher battery efficiency, which we show in Table 1 in the [appendices](#), than the Dell Latitude 7420, powered by an Intel Core i7-1185G7 vPro processor and a 63-Whr battery. However, our SYSmark 25 and CrossMark benchmark testing show that users could experience serious performance degradation while working unplugged on the AMD Ryzen 7 processor-powered laptop. The Dell Latitude 7420 laptop, powered by an Intel Core i7 processor, on the other hand, performed similarly well whether it was plugged in or not.



Work unplugged 43 minutes longer

MobileMark 2018 overall battery life (hh:mm) | More time is better

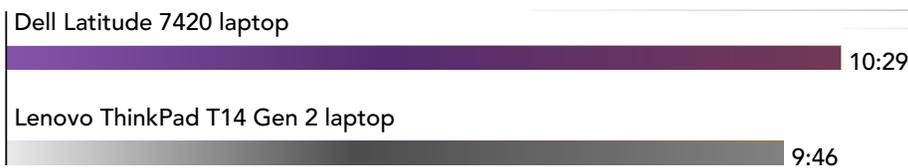


Figure 1: MobileMark 2018 overall battery life results. Time (hh:mm). More time is better.
Source: Principled Technologies.



Boost office productivity while unplugged with 25% better system responsiveness

MobileMark 2018 overall performance qualification | Higher is better

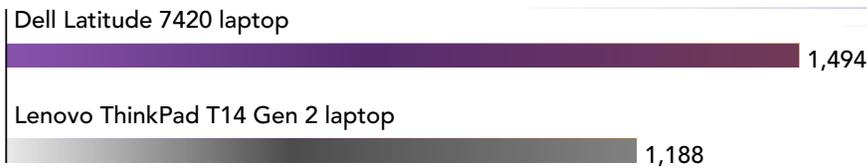
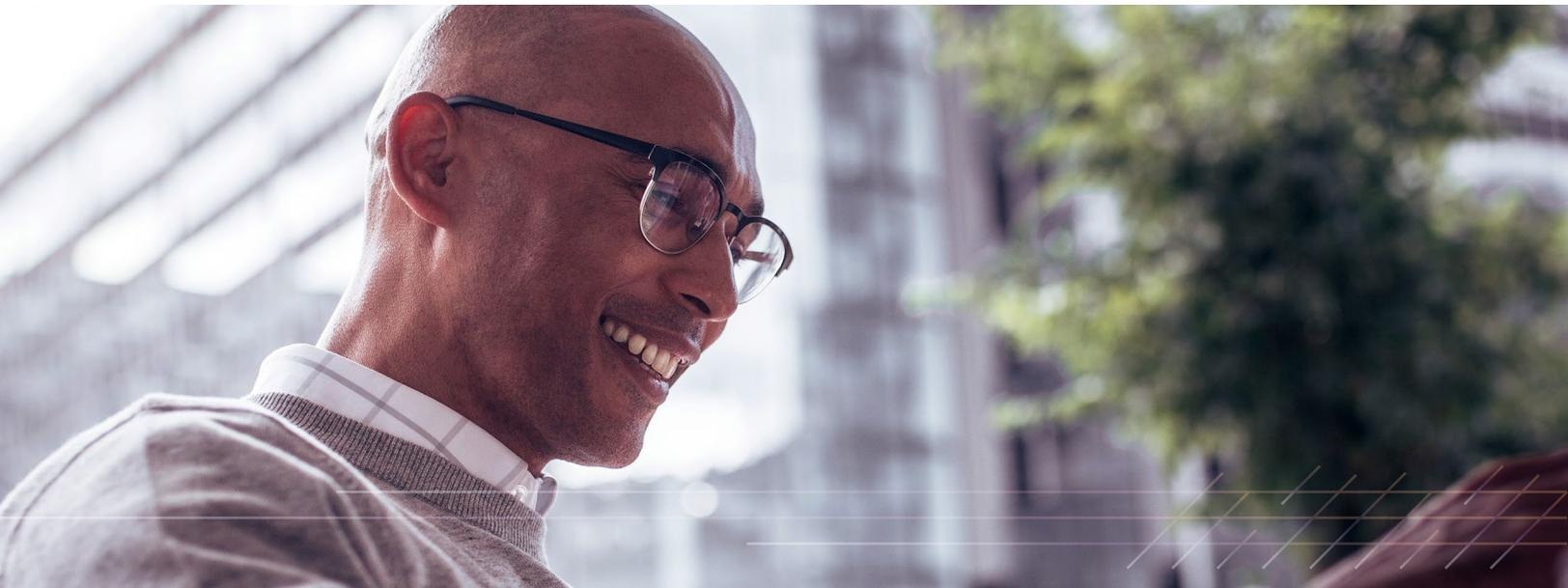


Figure 2: MobileMark 2018 overall performance qualification scores. Higher is better.
Source: Principled Technologies.



A different perspective on unplugged performance

We completed SYSmark 25 benchmark testing twice—once to measure plugged-in system performance and again to see how the business laptops performed while unplugged. Figure 3 shows the median scores of three individual, plugged-in runs. Then, we unplugged the laptops and ran SYSmark 25 three more times, stopping to fully recharge each laptop after every run. Figure 4 shows the median scores from those three unplugged runs.

During the plugged-in SYSmark 25 benchmark test, the Dell Latitude 7420 laptop, powered by a four-core Intel Core i7-1185G7 vPro processor, received a higher SYSmark 25 overall performance rating than the Lenovo ThinkPad T14 Gen 2 laptop powered by an eight-core AMD Ryzen 7 PRO 5850U processor.



Make the most of your plugged-in time with 19% better system performance

SYSmark 25 plugged-in overall performance rating | Higher is better

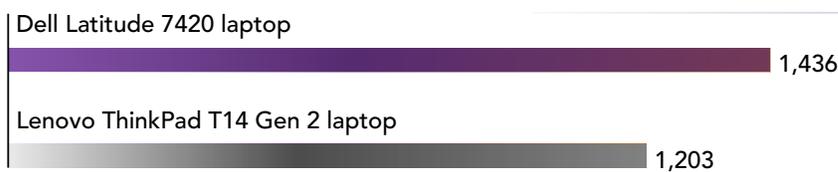


Figure 3: SYSmark 25 plugged-in overall performance ratings. Higher is better. Source: Principled Technologies.

In the unplugged SYSmark 25 benchmark test, the performance numbers for the Lenovo ThinkPad T14 Gen 2 laptop, powered by an eight-core AMD Ryzen 7 PRO 5850U processor, dropped 27 percent compared to the less than 1 percent drop on the Dell Latitude 7420 laptop powered by a four-core Intel Core i7-1185G7 vPro processor. This drop resulted in a 63 percent performance win for the Dell Latitude 7420 laptop, powered by a four-core Intel Core i7-1185G7 vPro processor, when running on battery.



Make the most of your unplugged time with 63% better system performance

SYSmark 25 unplugged overall performance rating | Higher is better

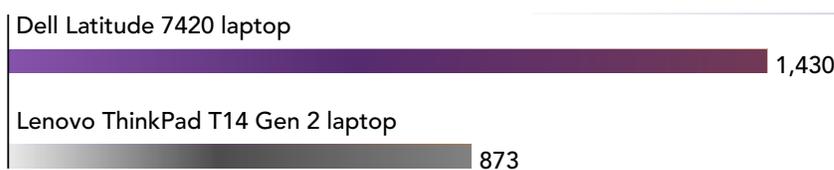


Figure 4: SYSmark 25 unplugged overall performance ratings. Higher is better. Source: Principled Technologies.



Photo: Principled Technologies

Accelerate day-to-day activities

We also completed CrossMark benchmark testing twice—once to measure plugged-in system performance and again to determine what performance slowdowns users could expect while working unplugged. Figure 5 shows the median scores of three individual, plugged-in runs. Then, we unplugged the laptops and ran CrossMark three more times, stopping to fully recharge each laptop after every run. Figure 6 shows the median scores from those three unplugged runs.

In our plugged-in CrossMark benchmark comparison, the Dell Latitude 7420 laptop, powered by a four-core Intel Core i7-1185G7 vPro processor, outperformed the Lenovo ThinkPad T14 Gen 2 laptop powered by an eight-core AMD Ryzen 7 PRO 5850U processor.



Complete your to-do list faster while plugged in with 20% better system responsiveness

CrossMark overall score | Higher is better

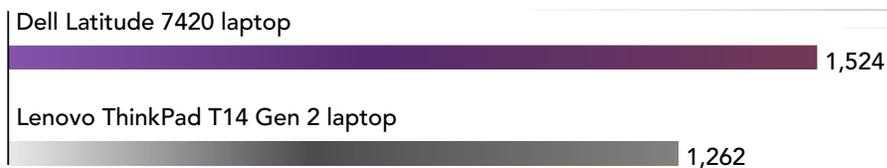


Figure 5: CrossMark overall scores while plugged in. Higher is better. Source: Principled Technologies.

Like the decreases in performance we saw in the SYSmark 25 benchmark tests, the unplugged CrossMark benchmark performance numbers for the Lenovo ThinkPad T14 Gen 2 laptop, powered by an eight-core AMD Ryzen 7 PRO 5850U processor, dropped 19 percent compared to the 4 percent drop on the Dell Latitude 7420 laptop powered by a four-core Intel Core i7-1185G7 vPro processor. This drop resulted in a 43 percent performance win for the Dell Latitude 7420 laptop, powered by a four-core Intel Core i7-1185G7 vPro processor, when unplugged.



Complete your to-do list while unplugged with 43% better system responsiveness

CrossMark overall score | Higher is better



Figure 6: CrossMark overall scores while unplugged. Higher is better. Source: Principled Technologies.

To review all benchmark results, detailed system information, and testing procedures, see the [appendices](#).

- 1 Dell Technologies, "Latitude 7420 Laptop or 2-in-1," accessed October 13, 2021, <https://www.dell.com/en-us/work/shop/2-in-1-laptops-tablets/latitude-7420-laptop-or-2-in-1/spd/latitude-14-7420-2-in-1-laptop>.
- 2 BAPCo, "MobileMark 2018," accessed October 13, 2021, <https://bapco.com/products/mobilemark-2018/>.
- 3 BAPCo, "SYSmark 25," accessed October 13, 2021, <https://bapco.com/products/sysmark-25/>.
- 4 BAPCo, "CrossMark," accessed October 13, 2021, <https://bapco.com/news/crossmark/>.

We concluded our hands-on testing on October 13, 2021. 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 September 22, 2021 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.

Table 1: Results of our benchmark testing. These scores and times are the median of three runs.

	Dell Latitude 7420 laptop powered by an Intel Core i7-1185G7 vPro processor	Lenovo ThinkPad T14 Gen 2 laptop powered by an AMD Ryzen 7 PRO 5850U processor	Percent difference
MobileMark 2018 v1.0.6.55 (unplugged)			
Overall battery life (hh:mm)	10:29	9:46	7.34%
Battery efficiency (min/Whr)	9.98	11.72	-14.81%
Overall performance qualification	1,494	1,188	25.76%
Productivity subscore	1,449	1,218	18.97%
Creativity subscore	1,596	1,172	36.18%
Web Browsing subscore	1,443	1,173	23.02%
SYSmark 25 v1.0.2.34 (plugged in)			
Overall rating	1,436	1,203	19.37%
Productivity	1,470	1,347	9.13%
Creativity	1,462	1,065	37.28%
Responsiveness	1,266	1,232	2.76%
SYSmark 25 v1.0.2.34 (unplugged)			
Overall rating	1,430	873	63.80%
Productivity	1,477	882	67.46%
Creativity	1,441	887	62.46%
Responsiveness	1,268	805	57.52%
CrossMark v1.0.0.75 Pro (plugged in)			
Overall rating	1,524	1,262	20.76%
Productivity	1,541	1,328	16.04%
Creativity	1,545	1,233	25.30%
Responsiveness	1,413	1,160	21.81%
CrossMark v1.0.0.75 Pro (unplugged)			
Overall rating	1,466	1,022	43.44%
Productivity	1,469	1,070	37.29%
Creativity	1,513	995	52.06%
Responsiveness	1,328	964	37.76%

System configuration information

Table 2: Detailed information on the systems we tested.

System configuration information	Dell Latitude 7420 laptop powered by an Intel Core i7-1185G7 vPro processor	Lenovo ThinkPad T14 Gen 2 laptop powered by an AMD Ryzen 7 PRO 5850U processor
Processor		
Vendor	Intel	AMD
Name	Core i7	Ryzen 7 PRO
Model number	1185G7	5850U
Core frequency (GHz)	3.0-4.8	1.9-4.4
Number of cores	4	8
Cache (MB)	12	16
Memory		
Amount (GB)	16	16
Type	DDR4	DDR4
Speed (MHz)	4,266	3,200
Graphics		
Vendor	Intel	AMD
Model number	Iris Xe Graphics	Radeon Graphics
Storage		
Vendor	KIOXIA	WDC
Model Number	KXG60ZNV256G	SN730
Amount (GB)	256	512
Type	M.2 PCIe® NVMe™	M.2 PCIe NVMe
Connectivity/expansion		
Wireless internet	Intel Wi-Fi® 6 AX201	Realtek RTL8852AE Wi-Fi 6 802.11AX
Bluetooth	5.1	5.2
USB	1 x USB 3.2 Gen 1 Type-A port with PowerShare 2 x USB 3.2 Gen 2 Type-C ports with Thunderbolt™ 4/Power Delivery/DisplayPort™	2 x USB-A 3.2 Gen 1 (1 always on) 2 x USB-C 3.2 Gen 2
Video	HDMI® 2.0	HDMI 2.0
Battery		
Type	4-cell lithium-ion	3-cell lithium-ion
Rated capacity (mAh)	63	50

System configuration information	Dell Latitude 7420 laptop powered by an Intel Core i7-1185G7 vPro processor	Lenovo ThinkPad T14 Gen 2 laptop powered by an AMD Ryzen 7 PRO 5850U processor
Display		
Size (in.)	14.0	14.0
Type	FHD	FHD
Resolution	1920 x 1080	1920 x 1080
Touchscreen	No	No
Operating system		
Vendor	Microsoft	Microsoft
Name	Windows 10 Pro	Windows 10 Pro
Build number or version	19043.1237	19043.1237
BIOS		
BIOS name and version	Dell 1.9.6	Lenovo R1MET39W (1.09)
Dimensions		
Height (in.)	0.68	0.70
Width (in.)	12.65	12.90
Depth (in.)	8.22	8.90
Weight (lbs.)	2.89	3.23

How we tested

Setting up the systems

Creating and updating the OEM Windows 10 Pro image

1. Boot the system.
2. To complete installation, follow the on-screen instructions, using the default selections when appropriate.
3. In the bottom right-hand corner, click the battery icon, and adjust the Windows Power mode (plugged in) to Best Performance.
4. Unplug the system. In the right-hand corner, click the battery icon, and adjust the Windows Power mode (on battery) to Best Performance. Plug the system back in.
5. Follow these steps to set DPI scaling to 100%, and set Screen and Sleep options to Never.
 - a. Right-click the desktop, and select Display settings.
 - b. Under the Scale and layout section, for the Change the size of text, apps, and other items option, select 100%.
 - c. From the left column, select Power & Sleep.
 - d. For all power options listed under Screen and Sleep, select Never.
6. Follow these steps to disable User Account Control notifications:
 - a. Select Windows Start, type UAC, and press Enter.
 - b. Move the slider control to Never notify, and click OK.
7. Run Windows Update, and install all updates available.
8. Launch the Windows Store app, and install all Store app updates.
9. Follow these steps to launch each vendor proprietary utility app installed on each system, and update any drivers or BIOS files:
 - a. For Dell, run the Dell Command Update utility.
 - b. For Lenovo, run the Lenovo Vantage utility.
 - c. To install the latest chipset and graphics drivers available, go to either <https://www.intel.com/content/www/us/en/support.html> or <https://www.amd.com/en/support>.
10. Verify the date and time are correct, and synchronize the system clock with the time server.
11. On the system with an AMD processor, in order to ensure the screen brightness stays consistent while unplugged, adjust the AMD Vari-Bright setting to Maximum brightness:
 - a. Right-click the desktop, and select AMD Radeon Software.
 - b. At the Welcome to the new Radeon Software experience, click Skip This.
 - c. In the top right corner, click the Settings Gear icon.
 - d. Click the Display tab.
 - e. Move the Vari-Bright slider to Maximum brightness.
12. Follow these steps to disable Automatic Windows Update:
 - a. Right-click Windows Start.
 - b. Select Computer Management.
 - c. Select Services and Applications.
 - d. Select Services.
 - e. Scroll down, and double-click Windows Update.
 - f. Click Stop.
 - g. From the startup-type drop-down menu, select Disabled.

Capturing an image

1. Connect an external HDD to the system.
2. Right-click desktop, and select Personalize → Home → Update & security → Backup → More options → See advanced settings → System Image Backup → Create a system image.
3. Verify that the external HDD is selected as the save drive, and click Next.
4. Verify that all drives are selected to back up, and click Next.
5. Click Start backup.
6. When the system asks whether you want to create a system repair disc, select No, and close the dialogs.

Restoring an image

1. Connect an external HDD to the system.
2. While restarting the system, press the Shift key, and hold it.
3. Select Troubleshoot.
4. Select Advanced options.
5. Select System image recovery.
6. Select the User account.
7. Enter the system password, and click Continue.
8. Verify that the external HDD is selected, and click Next.
9. Once the recovery has completed, click Finish.

Measuring performance with MobileMark 2018

Avoiding antivirus software conflicts

MobileMark 2018 is not compatible with any virus-scanning software, so we uninstalled any such software present on the notebook PCs before we installed the benchmark.

Avoiding pre-installed software conflicts

MobileMark 2018 installs the following applications, which its test scripts employ:

Productivity

- Adobe® Acrobat® Pro DC
- AutoIT 3.3.14.2
- Google Chrome™
- Microsoft Excel 2016
- Microsoft OneNote 2016
- Microsoft Outlook 2016
- Microsoft PowerPoint 2016
- Microsoft Word 2016
- Windows Zip

Creativity

- Adobe Photoshop® CC
- Adobe Lightroom® Classic CC
- CyberLink PowerDirector® 2015

Web Browsing

- Google Chrome
- Microsoft Movies & TV

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 MobileMark 2018 uses—before we installed the benchmark.

Adjusting display brightness and power settings

The brightness of a laptop's display affects its battery life. Before you test with MobileMark 2018, BAPCo requires that you ensure the brightness of the laptop's monitor is greater than or equal to 200 nits in the center of a completely white screen while the laptop is unplugged and running on battery power. The measurement follows the standards from the Video Electronics Standards Association (www.vesa.org).

We complied with this standard for all our tests by setting each laptop's brightness as close to 200 nits as we could without going below that level. We used the following procedure before we started each test. Note: This procedure assumes we began with the laptop plugged into the power supply.

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

Using the MobileMark built-in configuration tool

This tool supports three levels of configuration:

- Only makes changes that are REQUIRED for the benchmark to run.
- Additionally, makes changes that are RECOMMENDED for repeatable results.
- 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
- Enables Windows Search

Level 2 - Recommended

- Create BAPCo power scheme
- Set Power Plan Type to Balanced
- Set CPU Adaptive Mode
- Disables Battery Saver Dimming
- Verifies Battery Saver Threshold
- 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
- Disables Windows Defender
- Disables Windows Firewall
- Set Font Smoothing

Level 3 - Optional

- Disables Hard Disk Timeout
- Disables System Restore
- Ignores Laptop Lid Close

We chose the official BAPCo "Run Benchmark" default as outlined in the BAPCo MobileMark2018 User Guide (http://bapco.com/wp-content/uploads/2019/03/BAPCo_MobileMark2018_user_guide_v1.3.pdf), which runs the benchmark using the Required and Recommended options.

Setting up the performance-qualified battery life test

1. Verify that the wireless adapter is enabled and connected to a wireless router that is not connected to the internet.
2. Verify that the screen brightness is set to no less than 200 nits.
3. Install MobileMark 2018 with the default options.

Running the performance-qualified battery life 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 MobileMark 2018.
7. Click the Settings Gear icon.
8. Verify that Conditioning Run is enabled.
9. Enter a name for the benchmark run.
10. To return to the main menu, click Back.
11. Click Run Benchmark.
12. When prompted, unplug the AC power adapter. The test will begin immediately.

The benchmark is complete when the laptop has fully depleted its battery and is no longer operational when running on battery power.

We executed the MobileMark 2018 benchmark three times on the system and took the median performance score run as the representative battery life result for that test.

Measuring performance with SYSmark 25

Avoiding antivirus software conflicts

SYSmark 25 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 25 installs the following applications, which its test scripts employ:

Productivity

- Adobe Acrobat Pro DC
- Audacity 2.3.2
- AutoIT 3.3.15.2
- Corel WinZip 24 Enterprise
- Google Chrome
- Microsoft Excel 2019
- Microsoft Outlook 2019
- Microsoft PowerPoint 2019
- Microsoft Word 2019
- Shotcut v19.09.14

Creativity

- Adobe Lightroom Classic CC 2019
- Adobe Premiere® Pro CC 2019 v20.0.6
- Adobe Photoshop CC 2019 v13.1.5

Responsiveness

- Adobe Acrobat Pro DC
- Adobe Lightroom Classic CC 2019
- Adobe Premiere Pro CC 2019
- Adobe Photoshop CC 2019
- Google Chrome
- Microsoft Excel 2019
- Microsoft Outlook 2019
- Microsoft PowerPoint 2019
- Microsoft Word 2019

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 25 uses—before we installed the benchmark.

Using the SYSmark built-in configuration tool

This tool supports three levels of configuration:

- Only makes changes that are REQUIRED for the benchmark to run.
- Additionally, makes changes that are RECOMMENDED for repeatable results.
- 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
- 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
- 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
- Disables Windows Defender
- Disables Windows Firewall
- Set Font Smoothing

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 SYSmark2018 User Guide (https://bapco.com/wp-content/uploads/2020/09/BAPCo_SYSmark25_user_guide_v1.4.pdf), which runs the benchmark using the Required and Recommended options.

Setting up the test

1. Install SYSmark 25 with the default options.
2. Install the latest patch as of July 27, 2021, SYSmark25_Patch2_1.0.2.34.

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 25.
7. Click 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 25 benchmark results.
14. Repeat steps 1 through 13 twice more, for a total of three test runs, and report the median results.

For the plugged-in test, we ran SYSmark 25 one run at a time. We repeated this three times and reported the median scores from those three individual runs.

For the unplugged test, we unplugged the laptops and ran SYSmark 25 one run at a time, stopping to fully recharge each laptop after every run. We repeated this three times and reported the median scores from those three individual runs.

Measuring performance with CrossMark

Setting up the test

1. Download and install CrossMark from the Microsoft Store using the registered Microsoft Store account.
2. Launch CrossMark.
3. Click Accept at the license agreement screen.
4. Click Settings.
5. Click Restore Purchase.
6. At the Success screen, click Ok, and close CrossMark.
7. Follow the instruction found in the [BAPCo CrossMark user guide](#), and make the following system configuration changes:
 - a. Disable User Account Control
 - i. To open the Registry Editor, click the Windows start icon, type `regedit` in the search field, and press Enter.
 - ii. Go to `HKEY_LOCAL_MACHINE → SOFTWARE → Microsoft → Windows → CurrentVersion → Policies → System`.
 - iii. Double-click `EnableLUA`. In the value data field, type `0`, and click OK.
 - iv. Double-click `ConsentPromptBehaviorAdmin`. In the value data field, type `0`, and click OK.
 - b. Set Power Plan Type to High Performance:
 - i. Press `Windows+X`, and select `Windows Powershell (Admin)`.
 - ii. Type `powercfg.exe -SETACTIVEINDEX SCHEME_CURRENT SUB_NONE 245d8541-3943-4422-b025-13a784f679b7 1`, and press Enter.
 - iii. Close Windows PowerShell.
 - c. Disable WinSAT service:
 - i. To open the Task Scheduler, click the Windows start icon. In the search field, type `task scheduler`, and press Enter.
 - ii. Click `Task Scheduler Library → Microsoft → Windows → Maintenance`, right-click `WinSAT`, and select `Disable`.
 - d. Disable Windows Update:
 - i. Click the Windows start icon, and select `Settings → Update & Security → Windows Update`.
 - ii. Select `Advanced Options`, and turn off the following:
 - ◆ Receive updates for other Microsoft products when you update Windows
 - ◆ Download updates over metered connections
 - ◆ Restart this device as soon as possible when a restart is required to install an update
 - ◆ Show a notification when your PC requires a restart to finish updating.
 - e. Disable Windows Search, Diagnostic policy service, and SysMain service:
 - i. Click the Windows start icon. In the search field, type `services`, and press Enter.
 - ii. Right-click `Diagnostic policy service`, and select `Stop`.
 - iii. Double-click `Diagnostic policy service`. From the startup-type drop-down menu, select `Disabled`, click `Apply`, and click `Ok`.
 - iv. Right-click `Windows Search service`, and select `Stop`.
 - v. Double-click `Windows Search service`. From the startup-type drop-down menu, select `Disabled`, click `Apply`, and click `Ok`.
 - vi. Right-click `SysMain service`, and select `Stop`.
 - vii. Double-click `SysMain service`. From the startup-type drop-down menu, select `Disabled`, click `Apply`, and click `Ok`.
 - f. Disable Windows Security Center:
 - i. To open the Registry Editor, click the Windows start icon. In the search field, type `regedit`, and press Enter.
 - ii. Go to `HKEY_LOCAL_MACHINE → SYSTEM → CurrentControlSet → Services → SecurityHealthService`.
 - iii. Double-click `Start`. In the value data field, type `4`, and click `Ok`.
 - iv. Go to `HKEY_LOCAL_MACHINE → SYSTEM → CurrentControlSet → Services → wscsvc`.
 - v. Double-click `Start`. In the value data field, type `4`, and click `Ok`.

- g. Disable Tamper protection:
 - i. Click the Windows start icon, and select Settings → Update & Security → Windows Security.
 - ii. Under Virus & Threat Protection settings, click Manage settings.
 - iii. Turn off Tamper protection.
- h. Disable Windows Defender:
 - i. To open the Registry Editor, click the Windows start icon. In the search field, type `regedit`, and press Enter.
 - ii. Go to HKEY_LOCAL_MACHINE → SOFTWARE → Policies → Microsoft → Windows Defender.
 - iii. Right-click Windows Defender, and select New → Key → DWORD (32-bit) Value.
 - iv. Type `DisableAntiSpyware`, and press Enter.
 - v. Double-click `DisableAntiSpyware`. In the value data field, type `1`, and click Ok.
- i. For the changes to take effect, reboot the system.

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 CrossMark.
7. Click Settings.
8. For Number of Iterations, choose 1.
9. Enter a valid email address, and click Back.
10. Click Run Benchmark.
11. Record the result, and shut down the system.
12. Repeat steps 1 through 11 twice more, for a total of three test runs, and report the median results.

For the plugged-in test, we ran CrossMark one run at a time. We repeated this three times and reported the median scores from those three individual runs.

For the unplugged test, we unplugged the business laptops and ran CrossMark one run at a time, stopping to fully recharge each laptop after every run. We repeated this three times and reported the median scores from those three individual runs.

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