



Photo: Principled Technologies



## **A Dell Latitude 5420 laptop powered by a four-core Intel Core i5-1145G7 vPro processor received higher system performance and responsiveness benchmark scores**

**vs. an HP EliteBook 845 G8 laptop powered by a six-core AMD Ryzen 5 PRO 5650U processor**

We compared battery life as well as system performance and responsiveness on two 14-inch laptops: the Dell Latitude 5420 laptop powered by a four-core Intel® Core™ i5-1145G7 vPro® processor and the HP EliteBook 845 G8 laptop powered by a six-core AMD Ryzen™ 5 PRO 5650U processor.

For battery life and system performance metrics that reflect real-world business professional usage patterns, we ran the MobileMark® 2018 benchmark. For system performance and responsiveness in situations where an outlet isn't always an option, we ran SYSmark® 25 and CrossMark™ benchmarks on both laptops—first while they were plugged in and again when they were unplugged.



**Work cord-free for close to 10 hours**

based on MobileMark 2018 battery life results



**Speed routine tasks with 52% better unplugged system performance**

based on SYSmark 25 overall ratings

## What we tested

We configured each Windows 10 Pro business laptop with 16 GB of dual-channel memory and the largest capacity batteries available for each model. While the Dell Latitude 5420 laptop contained twice the 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 5420 laptop** powered by a four-core 11th Gen Intel Core i5-1145G7 vPro processor with Intel Iris® Xe Graphics, 512 GB of M.2 NVMe™ storage, and a four-cell 63-Whr ExpressCharge™ capable battery.
- **HP EliteBook 845 G8 laptop** powered by a six-core AMD Ryzen 5 PRO 5650U processor with AMD Radeon® Graphics, 256 GB of M.2 NVMe storage, and a three-cell 53-Whr HP Fast Charge capable battery.

MobileMark 2018, SYSmark 25, and CrossMark are industry-standard benchmarks that put test devices through scenarios based on the real-world applications and activities business users encounter every day.<sup>1,2,3</sup> 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](#).



### Dell Latitude 5420 laptop

This 14-inch Windows 10 Pro business laptop features a bright screen with ComfortView Plus, built-in AI with Dell Optimizer, and touchless wake and lock with ExpressSign-in. You can also configure it with 11th Gen Intel Core i3, i5, or i7 vPro processors.<sup>4</sup>

Photo: Principled Technologies

## Longer battery life with stronger performance

In our MobileMark 2018 benchmark comparison, both laptops delivered more than a full workday of battery life. We also found that the HP EliteBook 845 G8 laptop with its AMD Ryzen 5 PRO 5650U processor and 53-Whr battery had higher battery efficiency, which we show in Table 1 in the [appendices](#), than the Dell Latitude 5420 powered by an Intel Core i5-1145G7 vPro processor and a 63-Whr battery. However, as we show on the following pages, our SYSmark 25 and CrossMark benchmark testing revealed that business users could experience significant performance degradation while working unplugged on the AMD Ryzen 5 processor-powered laptop. By comparison, the Dell Latitude 5420 laptop, with its Intel Core i5 processor, performed comparably whether it was plugged in or not.



### Work cord-free 32 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.



### Empower cord-free office productivity with 13% better system responsiveness

MobileMark 2018 overall performance qualification | Higher is better



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



## Minimal performance degradation while unplugged

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

During the plugged-in SYSmark 25 benchmark test, the Dell Latitude 5420 laptop, powered by a four-core Intel Core i5-1145G7 vPro processor, received a higher SYSmark 25 overall rating than the HP EliteBook 845 G8 laptop powered by a six-core AMD Ryzen 5 PRO 5650U processor.



### SYSmark plugged-in overall ratings

Higher is better

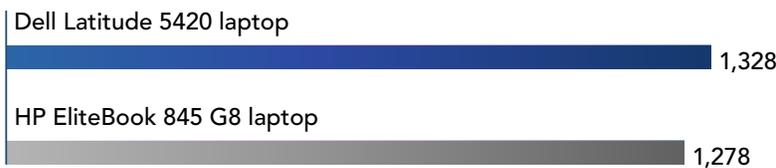


Figure 3: SYSmark 25 plugged-in overall ratings. Higher is better. Source: Principled Technologies.

In the unplugged SYSmark 25 benchmark test, the performance numbers for the HP EliteBook 845 G8 laptop, powered by an AMD Ryzen 5 PRO 5650U processor, dropped 34 percent—unlike the 2 percent drop we recorded on the Dell Latitude 5420 laptop with its Intel Core i5-1145G7 vPro processor. This drop resulted in an almost 53 percent cord-free win for the Dell Latitude 5420 laptop with its Intel Core i5-1145G7 vPro processor.



### Speed routine tasks with 52.8% better unplugged system responsiveness

SYSmark 25 unplugged overall performance rating | Higher is better

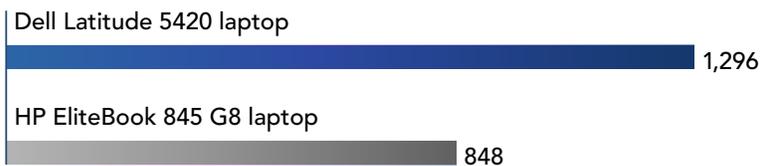


Figure 4: SYSmark 25 unplugged overall ratings. Higher is better. Source: Principled Technologies.



Photo: Principled Technologies

## Better performance when unplugged

We also completed CrossMark benchmark testing twice, once to measure plugged-in system performance and responsiveness and again to see how the business laptops performed unplugged. Figure 5 shows the median scores of three separate, plugged-in runs. Then, we unplugged the laptops and ran CrossMark three times again—this time stopping to fully recharge each laptop after every run. Figure 6 shows the median scores from those three runs.

In our plugged-in CrossMark benchmark comparisons, the HP EliteBook 845 G8 laptop, powered by a six-core AMD Ryzen 5 PRO 5650U processor, received a 3 percent higher overall rating than the Dell Latitude 5420 laptop, powered by a four-core Intel Core i5-1145G7 vPro processor.

### CrossMark plugged-in overall ratings

Higher is better

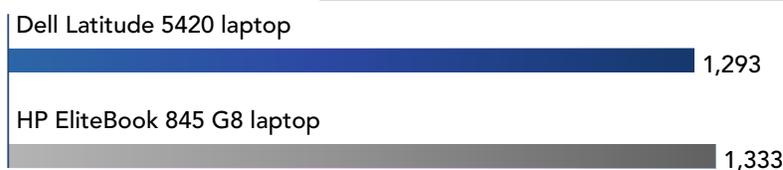


Figure 5: CrossMark plugged-in overall ratings. Higher is better. Source: Principled Technologies.

However, as we saw in the SYSmark 25 benchmark tests, the CrossMark performance numbers for the HP EliteBook 845 G8 laptop, powered by its AMD Ryzen 5 PRO 5650U processor, dropped as soon as we unplugged it. This 20 percent performance degradation resulted in a 17 percent cord-free win for the Dell Latitude 5420 laptop, powered by its Intel Core i5-1145G7 vPro processor.

### Accomplish more with 17.3% better unplugged system responsiveness

CrossMark overall score | Higher is better

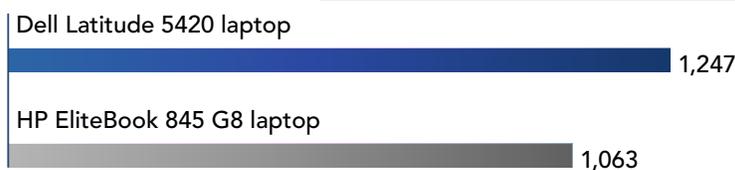


Figure 6: CrossMark unplugged overall ratings. Higher is better. Source: Principled Technologies.

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

- 1 BAPCo, "MobileMark 2018," accessed October 22, 2021, <https://bapco.com/products/mobilemark-2018/>.
- 2 BAPCo, "SYSmark 25," accessed October 22, 2021, <https://bapco.com/products/sysmark-25/>.
- 3 BAPCo, "CrossMark," accessed October 22, 2021, <https://bapco.com/products/crossmark/>.
- 4 Dell, "Latitude 5420 Laptop," accessed October 21, 2021, <https://www.dell.com/en-us/work/shop/dell-laptops-and-notebooks/latitude-5420-laptop/spd/latitude-5420-laptop>.

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 testing

	Dell Latitude 5420 laptop powered by an Intel Core i5-1145G7 vPro processor	HP EliteBook 845 G8 laptop powered by an AMD Ryzen 5 PRO 5650U processor	Percent difference
MobileMark 2018 v1.0.6.55 (unplugged)			
<b>Overall battery life (hh:mm)</b>	<b>9:54</b>	<b>9:22</b>	<b>5.69%</b>
<b>Battery efficiency (min/Whr)</b>	<b>9.42</b>	<b>10.60</b>	<b>-11.13%</b>
<b>Overall performance qualification</b>	<b>1,369</b>	<b>1,209</b>	<b>13.23%</b>
Productivity subscore	1,318	1,218	8.21%
Creativity subscore	1,462	1,299	12.55%
Web Browsing subscore	1,331	1,117	19.16%
SYSmark 25 v1.0.2.34 (plugged in)			
<b>Overall rating</b>	<b>1,328</b>	<b>1,278</b>	<b>3.91%</b>
Productivity	1,355	1,384	-2.10%
Creativity	1,342	1,195	12.30%
Responsiveness	1,210	1,228	-1.47%
SYSmark 25 v1.0.2.34 (unplugged)			
<b>Overall rating</b>	<b>1,296</b>	<b>848</b>	<b>52.83%</b>
Productivity	1,345	869	54.78%
Creativity	1,279	855	49.59%
Responsiveness	1,205	768	56.90%
CrossMark v1.0.0.75 Pro (plugged in)			
<b>Overall rating</b>	<b>1,293</b>	<b>1,333</b>	<b>-3.00%</b>
Productivity	1,360	1,346	1.04%
Creativity	1,240	1,369	-9.42%
Responsiveness	1,258	1,198	5.01%
CrossMark v1.0.0.75 Pro (unplugged)			
<b>Overall rating</b>	<b>1,247</b>	<b>1,063</b>	<b>17.31%</b>
Productivity	1,312	1,081	21.37%
Creativity	1,203	1,075	11.91%
Responsiveness	1,193	976	22.23%

## System configuration information

Table 2: Detailed information on the system we tested.

System configuration information	Dell Latitude 5420 laptop powered by an Intel Core i5-1145G7 vPro processor	HP EliteBook 845 G8 laptop powered by an AMD Ryzen 5 PRO 5650U processor
Processor		
Vendor	Intel	AMD
Name	Core i5	Ryzen 5 PRO
Model number	1145G7	5650U
Core frequency (GHz)	2.6-4.4	2.3-4.2
Number of cores	4	6
Cache (MB)	12	16
Memory		
Amount (GB)	16 (2 x 8GB)	16 (2 x 8GB)
Type	DDR4	DDR4
Speed (MHz)	3,200	3,200
Graphics		
Vendor	Intel	AMD
Model number	Iris Xe Graphics	Radeon Graphics
Storage		
Vendor	Samsung®	Samsung
Model Number	PM991a	PM981a
Amount (GB)	512	256
Type	M.2 PCIe® NVMe	M.2 PCIe NVMe
Connectivity/expansion		
Wireless internet	Intel Wi-Fi® 6 AX201	Intel Wi-Fi 6 AX200
Bluetooth	5.2	5.0
USB	2 x USB 3.2 Gen 1 Type-A port (1 with PowerShare)  2 x USB 3.2 Gen 2 Type-C ports with Thunderbolt™ 4/DisplayPort Alt Mode/ USB4/Power Delivery	2 x USB 3.2 Gen 1 Type-A port (1 charging)  2 Type-C ports Thunderbolt (USB Power Delivery/DisplayPort)2
Video	HDMI® 2.0	HDMI 2.0
Battery		
Type	4-cell lithium-ion	3-cell lithium-ion
Rated capacity (mAh)	63	53

<b>System configuration information</b>	<b>Dell Latitude 5420 laptop</b> powered by an Intel Core i5-1145G7 vPro processor	<b>HP EliteBook 845 G8 laptop</b> powered by an AMD Ryzen 5 PRO 5650U processor
Display		
Size (in.)	14.0	14.0
Type	FHD	FHD
Resolution	1,920 x 1,080	1,920 x 1,080
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 1.11.2	HP T82 Ver.01.02.01
Dimensions		
Height (in.)	0.76	0.70
Width (in.)	12.65	12.73
Depth (in.)	8.35	8.44
Weight (lbs.)	3.03	3.02

# 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 HP, run the HP Support Assistant 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, 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](http://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](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](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 -SETACVALUEINDEX 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.

This project was commissioned by Dell Technologies.



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