



The science behind the report:

Adding Intel Optane memory accelerated an HP EliteDesk 800 G4 more than doubling the RAM

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 [Adding Intel Optane memory accelerated an HP EliteDesk 800 G4 more than doubling the RAM](#).

We concluded our hands-on testing on October 12, 2018. 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 10, 2018, or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Detailed explanation of cost analysis

Assumptions

Organization and scenario

The hypothetical organization in our model has 1,000 professional employees using older desktop computers that are due for replacement. To meet the robust computing needs of these employees, the organization is considering two upgrade options for an HP EliteDesk 800 G4 with 16GB RAM:

- Adding 16GB additional RAM
- Adding a 16GB Intel® Optane™ memory module

Employee profiles

We tested tasks using several standard office applications plus specialized applications for video and graphic creation and data analysis. Not all of the 1,000 users would use all of those applications and the frequency with which users would launch them and use them to perform tasks would vary.

The table below tells more about the three groups of workers for which the model organization would provide new desktop computers.

	Communicators	Content creators	Data analysts
Description	Use office applications to work with email, documents, spreadsheets, and PDFs	Use office applications plus specialized applications to create video and graphic content	Use office applications plus specialized database applications for data analysis
Applications this group uses	<ul style="list-style-type: none"> • Adobe® Acrobat® Reader® DC • Microsoft® Excel • Microsoft Outlook • Microsoft PowerPoint • Microsoft Word 	<ul style="list-style-type: none"> • Adobe Acrobat Reader • Adobe Photoshop® • Adobe Premiere® • Microsoft Excel • Microsoft Outlook • Microsoft PowerPoint • Microsoft Word 	<ul style="list-style-type: none"> • Adobe Acrobat Reader • Microsoft Access • Microsoft Excel • Microsoft Outlook • Microsoft PowerPoint • Microsoft Word
Percentage of total workers	10%	45%	45%
Number of workers in this group	100	450	450

Hardware costs

HP provided the hardware we tested. To obtain hardware costs, we configured similar devices on the HP Online Store¹ and report the list costs of those devices. We configured an HP EliteDesk 800 G4 with 16GB memory and report the price of that model; to that, we added the price of either a 16GB Intel Optane Memory module or 16GB additional RAM.

	HP EliteDesk 800 G4, 32GB RAM	HP EliteDesk 800 G4, 16GB RAM + 16GB Intel Optane
Price of device with 16GB RAM	\$1,632	\$1,632
Additional 16GB RAM	\$380	N/A
16GB Intel Optane memory	N/A	\$74
Desktop hardware total	\$2,012	\$1,706

Productivity value per hour of time spent/saved on tested tasks

Using a computer that can perform tasks in less time translates to improved productivity. To determine the dollar value of this increased productivity in our model organization, we started with a \$60.49 estimate of average employer costs per hour worked.² However, not every minute or second of saved time translates into increased productivity. Therefore, we assumed 80 percent of the hourly employer cost, \$48.39, for the productivity value per hour of the time saved on our tested tasks.

Application usage

We measured the time necessary to carry out the various tasks on the two configurations of the HP EliteDesk 800 G4. For our cost analysis, we translated those times into productivity cost. To do so, we first estimated the average frequency with which the three user groups in our model organization would perform each task weekly. All the workers would power on and restart their systems and use general office applications to work with email, documents, spreadsheets, and PDFs. Those in the content creation and data analysis roles would also use more specialized applications to perform their jobs. The following table shows our assumptions about task usage for the three worker groups.

¹ Source for pricing: HP online store, accessed October 25, 2018, <https://store.hp.com/us/en>.

² The hourly figure of \$60.49, including both wages and benefits, is for the “management, professional and related” occupational group, from a September 2018 news release from the Bureau of Labor Statistics that reports data from June 2018 <https://www.bls.gov/news.release/pdf/ecec.pdf> (accessed on October 25, 2018).

Weekly frequency of tasks for each group of workers

	Communicators	Content creators	Data analysts
System tasks			
Copy files	25	25	25
Power on	5	5	5
Restart	5	5	5
Shut down	5	5	5
Opening applications and files			
Adobe Acrobat Reader DC - launch and open PDF	15	5	5
Adobe Acrobat Reader DC - send PDF to Microsoft OneNote	1	0	0
Adobe Photoshop - convert project to JPEG	0	10	0
Adobe Photoshop - launch and open project	0	10	0
Adobe Premiere - launch and open project	0	10	0
Microsoft Access - launch and open database	0	0	25
Microsoft Access - save database	0	0	25
Microsoft Excel - open workbook	10	1	10
Microsoft Outlook - launch	25	25	25
Microsoft Outlook - open PowerPoint attachment	2	1	1
Microsoft PowerPoint - convert to PDF	1	1	1
Microsoft PowerPoint - launch and open presentation	1	0	0
Microsoft Word - launch and open document	25	10	10

Productivity cost

We calculated daily productivity cost for each task on each device by multiplying the following:

- Task frequency per day across all 1,000 users in the three worker groups
- Median tested time (in seconds) to complete the task
- Cost per second (calculated from estimated employer expenditure for salary and benefits described on previous page)

We then added the costs per task and device and multiplied this number by the total number of workweeks in three years. (52 weeks x three years). The table below shows the final productivity cost results.

	HP EliteDesk 800 G4, 32GB RAM	HP EliteDesk 800 G4, 16GB RAM + 16GB Intel Optane	Savings with Intel Optane	Savings with Intel Optane (percentage)
Productivity cost estimate over three years for tested tasks (USD)	\$5,646,480	\$1,656,132	\$3,990,348	70.7%
Desktop hardware costs for 1,000 systems (USD)	\$2,012,000	\$1,706,000	\$306,000	15.2%
Total cost	\$7,658,480	\$3,362,132	\$4,296,348	56.1%

Our results

The table below presents our findings in detail. All times are in seconds. We conducted three runs and present the median results.

		HP EliteDesk 800 G4, 32GB RAM	HP EliteDesk 800 G4, 16GB RAM + 16GB Intel Optane	Time saved	Time saved (percentage)
System tasks	Copy file	7.5	1.5	6.0	80.0%
	Restart	115.1	34.0	81.1	70.5%
	Shut down	10.9	7.7	3.2	29.4%
	Power on	58.5	9.3	49.2	84.1%
Application tasks	Adobe Acrobat Reader DC - launch and open PDF	19.5	4.9	14.6	74.9%
	Adobe Acrobat Reader DC - send PDF to OneNote	34.1	28.1	6.0	17.6%
	Adobe Photoshop - convert project to JPEG	1.3	1.2	0.1	7.7%
	Adobe Photoshop - launch and open project	68.2	8.6	59.6	87.4%
	Adobe Premiere - launch and open project	57.3	10.8	46.5	81.2%
	Microsoft Access - launch and open database	14.9	2.4	12.5	83.9%
	Microsoft Access - save database	11.3	3.9	7.4	65.5%
	Microsoft Excel - launch and open workbook	17.9	5.7	12.2	68.2%
	Microsoft Outlook - launch	13.3	5.6	7.7	57.9%
	Microsoft Outlook - open PowerPoint attachment	6.5	1.8	4.7	72.3%
	Microsoft PowerPoint - convert to PDF	11.1	9.7	1.4	12.6%
	Microsoft PowerPoint - launch and open presentation	40.5	36.1	4.4	10.9%
	Microsoft Word - launch and open document	9.5	7.7	1.8	18.9%

System configuration information

The table below presents detailed information on the systems we tested.

System configuration information	HP EliteDesk 800 G4, 32GB RAM	HP EliteDesk 800 G4, 16GB RAM + 16GB Intel Optane
Processor		
Vendor	Intel	Intel
Name	Core™ i5	Core i5
Model number	8600	8600
Core frequency (GHz)	3.10 – 4.30	3.10 – 4.30
Number of cores	6	6
Cache	9MB SmartCache	9MB SmartCache
Memory		
Amount (GB)	32	16
Type	DDR4	DDR4
Speed (MHz)	2,666	2,666
Intel Optane memory		
Amount (GB)	N/A	16
Type	N/A	Intel Optane
Graphics		
Vendor	Intel	Intel
Model number	UHD Graphics 630	UHD Graphics 630
Storage		
Amount (GB)	500	500
Type	7,200 RPM	7,200 RPM
Connectivity/expansion		
Wired internet	Intel Ethernet I219-LM	Intel Ethernet I219-LM
USB	4 x USB 2.0 ports 4 x USB 3.1 Gen 2 ports 2 x USB 3.1 Gen 1 ports 1 x USB Type-C port	4 x USB 2.0 ports 4 x USB 3.1 Gen 2 ports 2 x USB 3.1 Gen 1 ports 1 x USB Type-C port
Video	1 x HDMI 2 x DisplayPort™	1 x HDMI 2 x DisplayPort
Operating system		
Vendor	Microsoft	Microsoft
Name	Windows 10 Pro	Windows 10 Pro
Build number or version	10.0.17134 Build 17134	10.0.17134 Build 17134
BIOS		
BIOS name and version	HP Q01 Ver. 02.02.04	HP Q01 Ver. 02.02.04

How we tested

Measuring time to perform routine operating system tasks

Setting up the systems

1. Open the services.msc Windows application.
2. Scroll down to the Superfetch service, right-click it, and select Properties.
3. In the Superfetch Properties window, under Service status, click Stop.
4. Set the Startup Type to Disabled.
5. Click Apply.
6. Close the Superfetch Properties window and the services.msc application.

Powering up and shutting down the system

1. Simultaneously start the timer and power on the system.
2. When the taskbar appears, stop the timer.
3. Record the result as the Power on time.
4. Bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
5. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
6. Do not interact with the system until the command completes.
7. After the command completes, wait five minutes before running the test.
8. Press the Windows key.
9. Click the Power button.
10. Simultaneously start the timer and click Shut down.
11. When the power LED turns off, stop the timer.
12. Record the result as the shutdown time.
13. Repeat steps 1 through 12 for a total of three times on each system.

Restarting

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Press the Windows key.
6. Click the Power button.
7. Simultaneously start the timer and click Restart.
8. When the taskbar appears, stop the timer.
9. Record the result as the Restart time.
10. Shut down the system.
11. Repeat steps 1 through 10 for a total of three times on each system.

Copying a file from desktop to documents

This test measured how long it took to copy a 610MB PDF from the Desktop to the Documents directory.

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.

5. Right-click on the 610MB PDF test file located on the Desktop, and select Copy.
6. Open the Documents directory, and right-click in the Documents directory.
7. Simultaneously click Paste and start the timer.
8. Stop the timer when the 610MB file has been successfully copied to the Documents directory.
9. Delete the file from the Documents directory.
10. Shut down the system.
11. Repeat steps 1 through 10 for a total of three times on each system.

Measuring time to perform application tasks

Setting up the Microsoft Office and Adobe tests

1. Install Microsoft Office 365 with default options.
2. Launch Word, Excel, PowerPoint, and OneNote and verify that there are no additional setup steps to take.
3. Install Adobe Acrobat Reader DC, Adobe Photoshop CC 2018, and Adobe Premiere CC 2018 with default options.
4. Launch Acrobat, Photoshop, and Premiere and verify that there are no additional setup steps to take.
5. Copy all test files to the desktop.

Launching Microsoft Word and opening a document

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test Word file and start the timer.
6. When the file is loaded into Word, stop the timer and record the result as the Microsoft Word document launch and load time.
7. Repeat steps 1 through 6 for a total of three times on each system.

Launching Microsoft Excel and opening a workbook

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test Excel file and start the timer.
6. When the file is loaded into Excel, stop the timer, and record the result as the Excel launch time.
7. Repeat steps 1 through 6 for a total of three times on each system.

Launching Microsoft PowerPoint, opening a presentation, and converting it to PDF

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test PowerPoint file and start the timer.
6. When the PowerPoint deck has loaded (as indicated by the last slide appearing in the left column), stop the timer, and record the result as the PowerPoint presentation load time.
7. Click File→Save As and select PDF (*.pdf) from the drop-down menu.
8. Simultaneously start the timer and click Save.
9. When the Publishing progress bar disappears, stop the timer, and record the result as the time to convert to PDF.
10. Close Microsoft PowerPoint.
11. Repeat steps 1 through 10 for a total of three times on each system.

Launching Microsoft Access, opening a database, and saving it

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test Access file and start the timer.
6. When the database has loaded (as indicated as the All Access Objects appearing in the left column), stop the timer, and record the result as the Access database load time.
7. Copy and paste the first 10 Access Objects listed in the left column. At the prompt, select copy Structure and data, and click OK.
8. Click File→Save As→Save Database As and give the file a name.
9. Simultaneously start the timer and click Save.
10. When the Saving Database progress bar disappears, stop the timer, and record the result as the time to save the database.
11. Close Microsoft Access.
12. Repeat steps 1 through 11 for a total of three times on each system.

Launching Microsoft Outlook and opening an email attachment

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open Microsoft Outlook and start the timer.
6. When Outlook has loaded (as indicated by All folders are up to date appearing in the bottom taskbar), stop the timer, and record the result as the Outlook load time.
7. Simultaneously start the timer and open the PowerPoint email attachment.
8. When the attachment has opened, stop the timer, and record the result as the time to open an email PowerPoint attachment.
9. Close Microsoft Outlook.
10. Repeat steps 1 through 9 for a total of three times on each system.

Launching Adobe Acrobat DC, opening a PDF, and sending it to OneNote

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test PDF file and start the timer.
6. When the file is loaded into Reader (as indicated by the right-hand task column fully loading), stop the timer, and record the result as the Acrobat Reader PDF load time.
7. Click the printer icon and select Send to OneNote 2016 from the Printer drop-down menu.
8. Simultaneously start the timer and click Print.
9. When the progress bar disappears, stop the timer, and record the result as the time to send an Adobe PDF to OneNote.
10. Close Adobe Acrobat Reader DC.
11. Repeat steps 1 through 10 for a total of three times on each system.

Launching Adobe Photoshop CC 2018, opening a project, and converting it to JPEG

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`

3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test Photoshop file and start the timer.
6. When the file is loaded into Photoshop (as indicated by the cursor changing from a spinning circle to a "+"), stop the timer, and record the result as the Photoshop file load time.
7. Click File→Save As.
8. From the drop-down menu, select JPEG, and enter a file name.
9. Click Save.
10. Move the Quality Slider button to 12 (Maximum).
11. Simultaneously click OK and start the timer.
12. Stop the timer when the progress bar in the bottom left of the screen indicates 100% and then disappears. Record the result as the time to convert a file in Adobe Photoshop.
13. Close Adobe Photoshop CC.
14. Repeat steps 1 through 13 for a total of three times on each system.

Launching Adobe Premiere Pro CC 2018 and opening a project

1. Power on the system and bring up an administrative command prompt:
 - a. Type `CMD`
 - b. Right-click the Command Prompt app to open App options.
 - c. Click the Run as administrator button.
2. Type `cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait five minutes before running the test.
5. Simultaneously open the test Premiere file and start the timer.
6. When the project is loaded into Adobe Premiere Pro, stop the timer, and record the result as the Premiere Pro project load time.
7. Close Adobe Premiere Pro CC.
8. Repeat steps 1 through 7 for a total of three times on each system.

Read the report at <http://facts.pt/pqv8ua2> ►

This project was commissioned by HP.



Facts matter.®

Principled Technologies is a registered trademark of Principled Technologies, Inc.
All other product names are the trademarks of their respective owners.

DISCLAIMER OF WARRANTIES; LIMITATION OF LIABILITY:

Principled Technologies, Inc. has made reasonable efforts to ensure the accuracy and validity of its testing, however, Principled Technologies, Inc. specifically disclaims any warranty, expressed or implied, relating to the test results and analysis, their accuracy, completeness or quality, including any implied warranty of fitness for any particular purpose. All persons or entities relying on the results of any testing do so at their own risk, and agree that Principled Technologies, Inc., its employees and its subcontractors shall have no liability whatsoever from any claim of loss or damage on account of any alleged error or defect in any testing procedure or result.

In no event shall Principled Technologies, Inc. be liable for indirect, special, incidental, or consequential damages in connection with its testing, even if advised of the possibility of such damages. In no event shall Principled Technologies, Inc.'s liability, including for direct damages, exceed the amounts paid in connection with Principled Technologies, Inc.'s testing. Customer's sole and exclusive remedies are as set forth herein.