The science behind the report:

# Boost PC performance: How more available memory can improve productivity

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 *Boost PC performance: How more available memory can improve productivity*.

We concluded our hands-on testing on February 7, 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 February 5, 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.

Table 1: Procyon Office Productivity scores. Higher scores are better.

| Platform | Dell™ Latitude 5440 | Dell Precision 3470 | Dell OptiPlex Tower Plus 7010 |
|---|---|---|---|
| **Baseline scenario (100% available memory)** | | | |
| **Procyon® Office Productivity overall rating - Run 1** | **6,052** | **6,340** | **6,832** |
| Word score | 6,413 | 6,978 | 7,533 |
| Excel score | 7,031 | 7,278 | 7,466 |
| PowerPoint score | 5,937 | 6,207 | 6,646 |
| Outlook score | 4,153 | 4,144 | 4,975 |
| **Procyon Office Productivity overall rating - Run 2** | **6,120** | **6,301** | **6,793** |
| Word score | 6,622 | 6,862 | 7,774 |
| Excel score | 7,011 | 7,096 | 7,429 |
| PowerPoint score | 5,971 | 6,318 | 6,337 |
| Outlook score | 4,187 | 4,167 | 4,985 |

| Platform | Dell™ Latitude 5440 | Dell Precision 3470 | Dell OptiPlex Tower Plus 7010 |
|---|---|---|---|
| **Procyon Office Productivity overall rating - Run 3** | **6,203** | **6,286** | **6,641** |
| Word score | 6,843 | 6,831 | 7,191 |
| Excel score | 7,046 | 7,159 | 7,476 |
| PowerPoint score | 6,035 | 6,260 | 6,280 |
| Outlook score | 4,178 | 4,142 | 5,003 |
| **Average Procyon Office Productivity overall rating (higher scores are better)** | **6,125** | **6,309** | **6,755** |
| **Multitasking scenario (50% available memory)** | | | |
| **Procyon Office Productivity overall rating - Run 1** | **3,414** | **4,902** | **5,518** |
| Word score | 3,934 | 5,570 | 6,865 |
| Excel score | 4,005 | 5,203 | 5,516 |
| PowerPoint score | 3,276 | 5,007 | 5,159 |
| Outlook score | 2,032 | 3,231 | 4,085 |
| **Procyon Office Productivity overall rating - Run 2** | **3,391** | **4,925** | **5,471** |
| Word score | 3,758 | 5,425 | 6,660 |
| Excel score | 3,743 | 5,384 | 5,591 |
| PowerPoint score | 3,564 | 5,068 | 5,168 |
| Outlook score | 2,055 | 3,208 | 3,965 |
| **Procyon Office Productivity overall rating - Run 3** | **3,362** | **4,914** | **5,586** |
| Word score | 3,758 | 5,491 | 6,713 |
| Excel score | 3,722 | 5,383 | 5,852 |
| PowerPoint score | 3,541 | 4,971 | 5,207 |
| Outlook score | 1,983 | 3,209 | 4,057 |
| **Average Procyon Office Productivity overall rating (higher scores are better)** | **3,389** | **4,914** | **5,525** |

Table 2: Time to complete Procyon Office Productivity benchmark. Less time is better.

| | Range - 100% available memory | Range - 50% available memory | Average - 100% available memory | Average - 50% available memory | Percentage less time to complete test (based on average) |
|---|---|---|---|---|---|
| Dell Latitude 5440 | 26:16 - 26:23 | 35:46 - 36:47 | 26:20 | 36:18 | 27.4% |
| Dell Precision 3470 | 26:14 - 26:22 | 29:49 - 31:41 | 26:19 | 30:39 | 14.1% |
| Dell OptiPlex Tower Plus 7010 | 24:39 - 24:46 | 26:29 - 26:37 | 24:43 | 26:33 | 6.9% |

## Memory utilization during testing

The charts in Figure 1 show the memory utilization during our idle, load, and test periods. We present the memory utilization for the median of three runs. The idle and load periods are 2 and 10 minutes respectively. The test period varies between tests, but lasts between 24 and 37 minutes. See Table 3 for details on average memory utilization over each period.
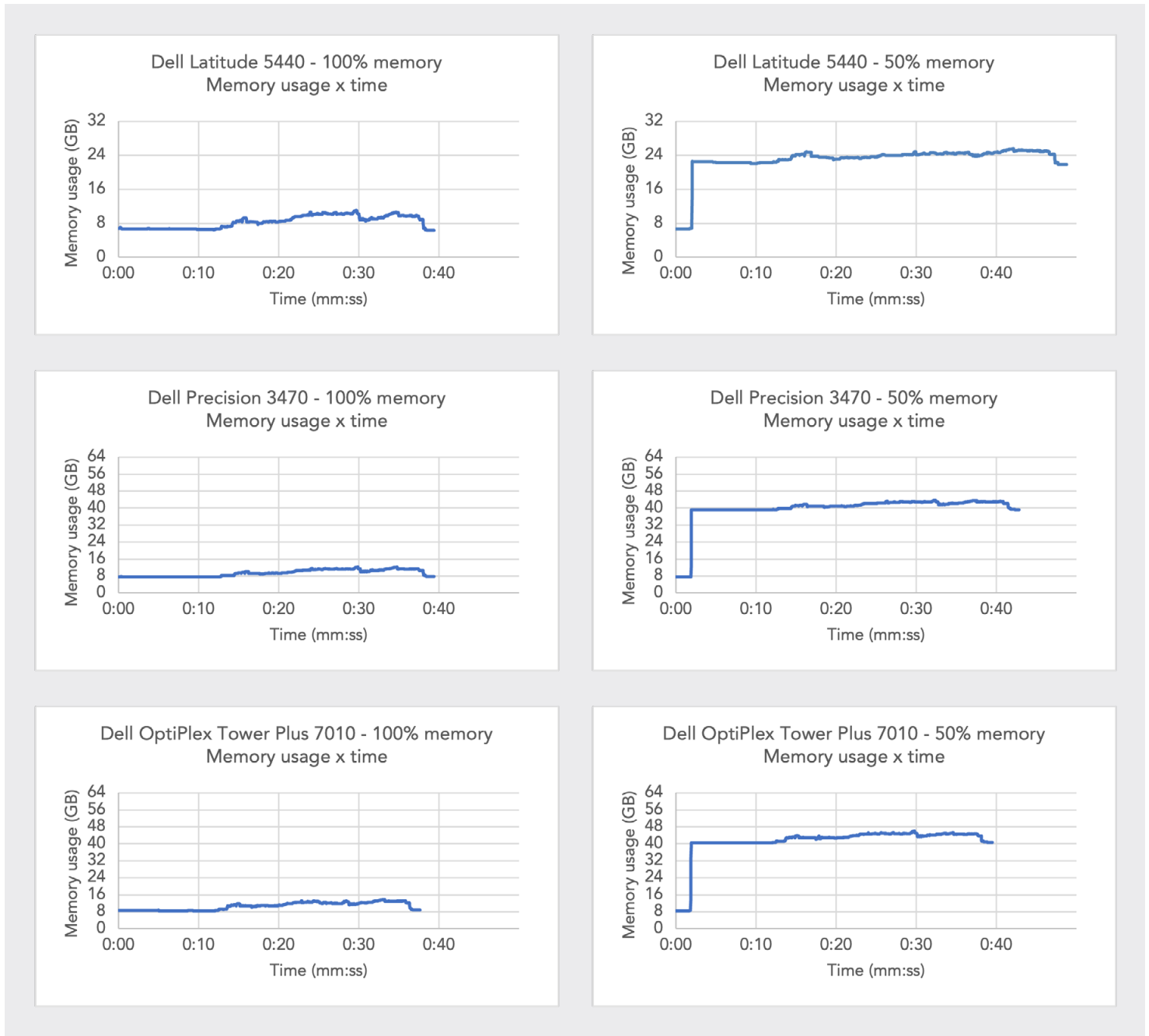
Figure 1: Memory usage during test periods.

Table 3: Memory usage during test periods (ranges).

| | Memory in system (GB) | Idle period - Memory utilization (% average range) | Load period - Memory utilization (% average range) | Test period - Memory utilization (% average range) |
|---|---|---|---|---|
| Dell Latitude 5440 100% of memory | 31.66 | 20.5% – 21.5% | 20.5% – 21.3% | 28.7% – 28.9% |
| Dell Latitude 5440 50% of memory | 31.66 | 20.4% – 21.1% | 69.6% – 70.4% | 75.9% – 76.3% |
| Dell Precision 3470 100% of memory | 63.24 | 11.9% – 12.0% | 11.6% – 11.8% | 16.0% – 16.2% |
| Dell Precision 3470 50% of memory | 63.24 | 12.8% – 14.4% | 61.6% – 61.9% | 66.0% – 66.2% |
| Dell OptiPlex Tower Plus 7010 100% of memory | 63.70 | 12.4% – 12.9% | 12.3% – 12.8% | 17.5% – 17.8% |
| Dell OptiPlex Tower Plus 7010 50% of memory | 63.70 | 15.5% – 16.5% | 62.9% – 63.3% | 67.9% – 68.5% |

# System configuration information

Table 4: Detailed information on the systems we tested.

| System | Dell Latitude 5440 | Dell Precision 3470 | Dell OptiPlex Tower Plus 7010 |
| --- | --- | --- | --- |
| Processor | | | |
| Vendor | Intel® | Intel | Intel |
| Model number | Core™ i5-1345U | Core i7-1270P | Core i7-13600 |
| Performance core base frequency (GHz) | 1.60 | 2.20 | 2.70 |
| Performance cores | 2 | 4 | 6 |
| Efficient core base frequency (GHz) | 1.20 | 1.60 | 2.00 |
| Efficient cores | 8 | 8 | 8 |
| Total number of cores | 10 | 12 | 14 |
| L3 cache (MB) | 12 | 18 | 24 |
| Memory | | | |
| Amount (GB) | 32 | 64 | 64 |
| Type | DDR4 SODIMM | DDR5 SODIMM | DDR5 UDIMM |
| Model 1 | M471A2G43AB2-CWE | MTC16C2085S1SC48BA1 | M323R2GA3BB0-CQWOL |
| Speed (MT/s) | 3200 | 4800 | 4800 |
| Model 2 | N/A | N/A | HMCG787AEBUA081N |
| Speed (MT/s) | N/A | N/A | 4800 |
| Integrated graphics | | | |
| Vendor | Intel | Intel | Intel |
| Model number | Iris® Xe Graphics | Iris Xe Graphics | UHD Graphics 770 |
| Storage | | | |
| Amount (GB) | 256 | 256 | 256 |
| Type | M.2 PCIe® NVMe® SSD | M.2 PCIe NVMe SSD | M.2 PCIe NVMe SSD |
| Connectivity/expansion | | | |
| Wired internet | 1x RJ-45 Ethernet port | 1x RJ-45 Ethernet port | 1x RJ-45 Ethernet port |
| Wireless manufacturer | Intel | Intel | Realtek |
| Wireless model | Wi-Fi 6E AX211 | Wi-Fi 6E AX211 | RTL8852BE Wi-Fi |
| Wireless internet | 802.11ax | 802.11ax | 8.02.11ax |
| Bluetooth | 5.3 | 5.3 | 5.2 |

| System | Dell Latitude 5440 | Dell Precision 3470 | Dell OptiPlex Tower Plus 7010 |
|---|---|---|---|
| USB ports | 2x USB 3.1 (Gen 1 with PowerShare) | 2x USB-A 3.2 (Gen 1 with PowerShare) | Front<br>1x USB 3.2 Gen 2x2 Type-C® port<br>1x USB 3.2 Gen 2 port<br>1x USB 2.0 port with PowerShare<br>1x USB 2.0 port<br>1x universal audio port<br><br>Back<br>3x USB 3.2 Gen 1 ports<br>1x USB 3.2 Gen 2 port<br>2x USB 2.0 ports with Smart Power On<br>1x re-tasking line out/line in audio port |
| Thunderbolt™ ports | 1x Thunderbolt 3 Type-C port | 2x USB Type-C Thunderbolt 4.0 with Power Delivery and DisplayPort | N/A |
| Video ports | HDMI® 2.0 | HDMI 2.0 | 3x DisplayPort™ 1.4 ports |
| Battery | | | |
| Type | Lithium-ion polymer | Lithium-ion polymer | N/A |
| Size | 3-cell | 4-cell | N/A |
| Rated capacity (WHr) | 56 | 64 | N/A |
| Display | | | |
| Size (in.) | 15.6 | 14 | N/A |
| Type | FHD | FHD | N/A |
| Resolution | 1920x1080 | 1920x1080 | N/A |
| Touchscreen | No | No | N/A |
| Operating system | | | |
| Vendor | Microsoft | Microsoft | Microsoft |
| Name | Windows 11 Pro | Windows 11 Pro | Windows 11 Pro |
| Build number or version | 10.0.22631 | 10.0.22631 | 10.0.22631 |
| BIOS | | | |
| BIOS name and version | Dell Inc. 1.10.0 (11/08/2023) | Dell Inc. 1.18.1 (11/10/2023) | Dell Inc. 1.10.0 (11/08/2023) |
| Dimensions | | | |
| Height (in.) | 0.66 | 0.82 | 14.45 |
| Width (in.) | 14.06 | 12.65 | 6.65 |
| Depth (in.) | 9.27 | 8.35 | 11.84 |
| Weight (lb.) | 3.93 | 3.30 | 13.07 |

# How we tested

We tested the effect of background memory utilization on a productivity workload. To generate our background memory load, we used PassMark BurnInTest 10.2. We used the Procyon Office Productivity benchmark to test performance, capturing benchmark scores. We captured details for the following test scenarios:

1. No background memory utilization
2. 50% background memory utilization

We captured three runs at each memory size and report the range of scores. The Dell Latitude 5440 had 32 GB of memory while both the Dell Precision 3470 and Dell OptiPlex Tower Plus 7010 had 64 GB of memory. Each of the three systems used between 7 GB and 8 GB of memory for system processes. We also measured the time to complete each benchmark run and the CPU utilization during the test period.

## Setting up the systems and test

### Creating and updating the OEM Windows 11 Pro image

1. Boot the system.
2. To complete installation, follow the onscreen instructions, using the default selections when appropriate.
3. In the bottom right corner, click the battery icon, and select Power & Battery.
4. Adjust the Windows Power mode (plugged in) to Best Performance.
5. Set DPI scaling to 100%, and set Screen and Sleep options to Never:

    i. Right-click the desktop, and select Display settings.
    ii. Under the Scale and layout section, for the Change the size of text, apps, and other items option, select 100%.
    iii. Expand Power → Screen and Sleep.
    iv. For all power options listed under Screen and Sleep, select Never.

6. Disable User Account Control notifications:

    i. Select Windows Start, type `UAC`, and press the Enter key.
    ii. 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. Launch the Dell Command Update utility app, and update any drivers or BIOS files.
10. Verify the date and time are correct, and synchronize the system clock with the time server.
11. Pause Windows updates for 5 weeks.

### Setting up the test

1. Download and install the PassMark BurnInTest software from *https://www.passmark.com/products/burnintest/price.php*.
2. Launch BurnInTest.
3. Enter the license key for BurnInTest, and click Continue.
4. Close the BurnInTest application.
5. Download and install the Procyon Office Productivity benchmark from *https://benchmarks.ul.com/procyon/office-productivity-benchmark*.
6. Launch Procyon.
7. Click Office Productivity Benchmark.
8. Click Register.
9. Enter the license key for the Office Productivity benchmark, and click Register.
10. Before running the benchmark, install a licensed version of Microsoft 365.
11. When prompted, update the Procyon to the latest version.

## Running the Procyon Office Productivity benchmark with no background memory utilization

### Testing with the Procyon Office Productivity benchmark

1. Select Windows Start.
2. Type `cmd`, and press Ctrl+Shift+Enter.
3. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
4. After the command completes, wait 5 minutes before running the test.
5. Launch Procyon.
6. Click the Office Productivity benchmark.
7. Simultaneously start a timer and click Run.
8. When the benchmark is complete, stop the timer, and record the benchmark scores.
9. Reboot the system.
10. Repeat steps 1 through 9 twice more.

## Running the Procyon Office Productivity benchmark with 50% background memory utilization

### Simulating background memory utilization

1. Launch PassMark BurnInTest.
2. Click Configuration → Test Selection & Duty Cycles, and in the Test Configuration dialog box on the left, select RAM.
3. Set Auto Stop to after 120 minutes or 0 cycles.
4. Deselect resources other than RAM.
5. Set RAM to 100.
6. Click Configuration → Test Preferences, and click the RAM tab.
7. Select Multi-Process Torture Test.
8. From the Test pattern drop-down menu, select 64-bit Sequence (0,1,2…)
9. Under the Multi-process torture test settings dialog, make the following selections:
    a. Number of processes: 2
    b. % of RAM per process: 25
10. Click OK.
11. Select Test → Start Test Run, and monitor the Task Manager to verify that the system memory utilization matches the target value before running the Procyon Office Productivity Benchmark. Note that this process can take roughly 10 minutes depending on the hardware you're testing.

### Testing with the Procyon Office Productivity benchmark

1. Select Windows Start.
2. Type `cmd`, and press Ctrl+Shift+Enter.
3. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
4. After the command completes, wait 5 minutes before running the test.
5. Launch Procyon.
6. Click the Office Productivity benchmark, but do not click Run. Let it sit in the background until instructed in step 8 below.
7. Complete the Simulating base memory utilization, using the settings from step 9 of Simulating background memory utilization.
8. Simultaneously start a timer and click Run.
9. When the benchmark is complete, stop the timer, and record the benchmark scores.
10. Reboot the system.
11. Repeat steps 1 through 10 twice more.

This project was commissioned by Dell Technologies.

## Principled Technologies®

Facts matter.®