PROWESS

NEWER DEVICES POWERED BY THE INTEL® VPRO™ PLATFORM OFFER BIG ADVANTAGES

Newer hardware helps bring benefits in TCO, productivity, security, and manageability that 4th generation devices can't match.

Executive Summary

Microsoft will discontinue mainstream support for Windows® 7 on January 14, 2020. With Windows 7 reaching the end of its lifecycle, enterprises know that upgrading to Windows 10 is now absolutely essential. But in light of this necessary upgrade, an important question arises: is it more advantageous to upgrade the operating system on existing client computers or to refresh the client machines along with the older operating system?

To find out, Prowess put old and newer client systems to the test, and our investigation revealed a clear answer.[1] Windows 10 devices that are powered by the Intel® vPro™ platform and 8th generation Intel® Core™ vPro™ processors with those built-in platform features enabled show significant benefits in manageability, productivity, and security compared to Windows 10 devices powered by six-year-old, 4th generation Intel Core vPro processors that do not have Intel vPro platform features enabled ("4th generation systems").[2] For full testing configurations and procedures, see **the appendices** of this report.

Does Investing in Newer Client Machines Pay Off?

As Windows 7 approaches its end of support, the clock is now ticking for businesses to migrate their clients to Windows 10. Enterprises eyeing the deadline early next year, however, are weighing the desirability of two different strategies. Is it better to migrate to Windows 10 on existing machines, or is it wiser to also refresh their client computers when making the switch to Windows 10?

Keeping existing hardware has the advantage of reducing upfront migration costs, but this option also comes with some significant downsides:

The analysis in this document was done by Prowess Consulting and commissioned by Intel.

- If a company's existing 4th generation systems are not equipped with Intel vPro processors, they do not include the same manageability features that 8th generation Intel Core vPro processor–based computers do.[2]
- 4th generation systems can require more time to complete tasks that are critical to the daily workflow for workers, potentially hindering productivity.
- 4th generation systems, whether they are Intel Core vPro processor–based or not, don't offer some of the latest security features. These features include improved malware protection and multifactor authentication keys, tokens, and policies that are all processed and stored in the chip.
- Some Windows 10 features (such as Accelerated Memory Scanning [AMS]) are built on new processor features, which means that Windows 10 running on a 4th generation processor might not offer the full potential benefits of the operating system.
- 4th generation systems are unable to take advantage of Intel® Optane™ technology to improve system responsiveness, especially for heavy computational workloads.

To help organizations make informed decisions and assess the benefits of purchasing newer computers for the latest operating system, we conducted testing that compared the performance and capabilities of Windows 10 running on 4th generation and newer systems.

All devices tested were Intel® Core™ vPro™ processor–based systems

Both the 4th generation systems and the newer devices we tested were Intel Core vPro processor–based computers. **However, for the older systems, we performed testing without using Intel® vPro™ platform features**—primarily as a way to simulate computers that were not Intel Core vPro processor–based because some 4th generation systems among the current install base of PCs are not Intel Core vPro processor–based. In other words, we wanted to compare the difference in capabilities between older systems for which the Intel vPro platform is unavailable and the Intel Core vPro processor–based systems to which businesses might migrate. In addition, we also know that many organizations do not currently take advantage of Intel vPro platform features such as Intel® Active Management Technology, even if their client systems are Intel Core vPro processor–based. As a secondary motivation, we wanted to call attention to the scenarios where the features of this platform would carry a significant advantage if they were enabled and used.

4th Generation and Newer Devices Tested

In our testing, we sought to complete typical tasks expected of various employees in a business with managed clients. We performed the same set of tasks on six different systems:

1. 4th generation system 1:
   - Model: Dell™ Latitude™ E5440
   - CPU: 4th generation Intel Core vPro i7 processor (Intel Core i7-4600U processor without Intel vPro platform features enabled)[2]

2. 4th generation system 2:

   - Model: HP® EliteBook® Folio® 9480m
   - CPU: 4th generation Intel Core vPro i7 processor (Intel Core i7-4600U processor without Intel vPro platform features enabled)[2]

3. 4th generation system 3:

   - Model: Lenovo® ThinkPad® T440s
   - CPU: 4th generation Intel Core vPro i7 processor (Intel Core i7-4600U processor without Intel vPro platform features enabled)[2]

4. Newer system 1:

   - Model: Dell Latitude 7290
   - CPU: 8th generation Intel Core vPro i7 processor (Intel Core i7-8650U processor with Intel vPro platform features enabled)

5. Newer system 2:

   - Model: HP EliteBook 840 G5
   - CPU: 8th generation Intel Core vPro i7 processor (Intel Core i7-8650U processor with Intel vPro platform features enabled)

6. Newer system 3:

   - Model: Lenovo ThinkPad T480s
   - CPU: 8th generation Intel Core vPro i7 processor (Intel Core i7-8650U processor with Intel vPro platform features enabled)

Tables 1 and 2 provide more complete details about the systems tested.

Table 1. 4th generation systems used in testing

4th generation Intel® Core™ vPro™ i7 processor–based systems[2]

Device	Dell™ Latitude™ E5440	HP® EliteBook® Folio® 9480m	Lenovo® ThinkPad® T440s
Processor	Intel Core i7-4600U processor	Intel Core i7-4600U processor	Intel Core i7-4600U processor
Intel® vPro™ Platform Eligibility[2]	Yes	Yes	Yes
Model Number	E5440	9480m	20ARS0LU00
Storage	240 GB SanDisk® SD7UB3Q256G1001 Serial Computer System Interface (SCSI) disk device	240 GB Lite-On™ LCS-256L9S-11 22 SCSI disk device	240 GB Samsung® MZ7TE256HMHP-000 SCSI disk device
Memory	8 GB	8 GB	8 GB
Graphics	Intel® HD Graphics family	Intel HD Graphics family	Intel HD Graphics family
Original Operating System	Windows® 7 Professional	Windows 7 Professional	Windows 7 Professional
BIOS	Dell Inc. A21, 2/1/2018	Hewlett-Packard® M85 Ver. 01.46, 8/8/2018	Lenovo GJET98WW (2.48), 3/20/2018

Table 2. 8th generation systems used in testing

8th generation Intel® Core™ vPro™ i7 processor–based systems

Device	Dell™ Latitude™ 7290	HP® EliteBook® 840 GS	Lenovo® ThinkPad® T480s
Processor	Intel Core i7-8650U processor	Intel Core i7-8650U processor	Intel Core i7-8650U processor
Intel® vPro™ Platform Eligibility	Yes	Yes	Yes
Model Number	7290	840 GS	20L7CTO1WW
Storage	256 GB Intel® SSD 540s Serial ATA (SATA)	240 GB MTFDDAV256TBN-1AR15ABHA	120 GB Samsung® MZNLN128HAHQ-000L1
Memory	8 GB	8 GB	8 GB
Graphics	Intel® UHD Graphics 620	Intel UHD Graphics 620	Intel UHD Graphics 620
Operating System	Windows® 10 Pro	Windows 10 Pro	Windows 10 Pro
BIOS	Dell Inc. 1.5.1, 7/12/2018	HP Q78 Ver. 01.01.08, 6/5/2018	Lenovo N22ET49W (1.26), 9/13/2018

Note: Our research focused on real-world performance gains for complete systems, so it does not distinguish processor gains from gains due to other hardware or software components.

System Configurations Tested

Using the three 4th generation and three newer systems described above, we compared performance and functionality across three configurations:

1. "Nothing upgraded" configuration: a 4th generation system running Windows 7
2. "Only the operating system upgraded" configuration: a 4th generation system running Windows 10
3. "Everything upgraded" configuration: a newer system running Windows 10

Typical Tasks Compared

Our testing revealed significantly better productivity, manageability, and security capabilities in the devices powered by the 8th generation Intel Core vPro processors.

In particular, our testing found that newer PCs with Windows 10 and 8th generation Intel Core vPro processors offered the following improvements over the 4th generation systems running the same operating system:

- Creating motion-path animations: Up to 1.6x faster performance (see **Appendix 1**)[3]
- Transcoding videos: Up to 2.3x faster performance (see **Appendix 2**)[3]
- Booting to a desktop: Up to 1.4x faster performance (see **Appendix 3**)[3,4]

In the following sections, we summarize our testing results and discuss how they might affect a typical medium-sized business. (Full results are available in **the appendices**.) To emulate real-world scenarios, we present this medium-sized business as a multi-branch engineering firm employing 450 people. Our fictional engineering company creates manufacturing parts and is distributed across three offices. All clients in the multi-branch firm are managed, but only two of the three offices have IT staff on hand.

Productivity Tasks

At the heart of every business operation is work being conducted by employees performing the core services or building the core solutions that the business's clients and customers pay for. That work might be performed in financial applications, in computer-assisted design (CAD) applications, or in some other applications specific to the line of business. For these applications that are key to a business's competitiveness, improving productivity and speed is highly desirable because it can speed the time to market for the business's goods and services and increase the rate at which the company can generate revenue.

PRODUCTIVITY TASK 1: CREATE A MOTION-PATH ANIMATION

According to our testing, an 8th generation Intel Core vPro processor performs up to 1.6x faster at creating a motion-path animation than does a 4th generation system with Windows 10 (**see Appendix 1**). The productivity gains we observed (averaging 9 minutes and 39 seconds of saved time per video) are especially notable because performance actually worsened for these same tasks on the 4th generation systems after the operating system was upgraded from Windows 7 to Windows 10.[5] (See **here** for detailed testing results.)

BENEFITS TO A MEDIUM-SIZED COMPANY

In our fictional engineering firm, our engineers use their client machines to collaborate on parts for manufacturing in CAD applications. For businesses such as these, that rely on creating videos with motion-path animations as part of their core services, an up **to 1.6x performance improvement** in these tasks is highly significant. If we suppose that the engineering company creates 10 such animations per month, the performance boost enabled by the newer systems could translate into *more than 19 hours* of *saved time* per year (9 minutes 39 seconds time saved per operation x 10 per month x 12 months).

The business's existing and prospective clients are likely to judge the speed at which the firm can deliver its core services as a measure of the company's basic competency, and their speed will naturally be compared to that of rival engineering firms. The speed of the CPU should not limit the competitiveness of an engineering firm. This one factor alone could justifiably motivate such a business to upgrade its systems to the latest-generation Intel Core vPro processors instead of keeping the old client systems and upgrading to Windows 10 in place.

PRODUCTIVITY TASK 2: TRANSCODING VIDEOS

In our testing, we found that our fictional engineering company could save up to 1 hour 15 minutes transcoding individual professional videos on a system with Windows 10 running on an 8th generation Intel Core vPro processor, compared to a system with Windows 10 running on a 4th generation Intel Core vPro processor. (See **here** for detailed testing results. Note that Intel® Quick Sync Video was implemented on both older and newer systems.)

BENEFITS TO A MEDIUM-SIZED COMPANY

Let's suppose that in our medium-sized engineering firm, the graphics team produces two videos for marketing and sales every month. In this case, the dramatic performance boost in transcoding videos made possible by newer systems powered by 8th generation Intel Core vPro processors could translate into up to *30 hours of saved time* (1 hour 15 minutes time saved x 2 per month x 12 months) for the engineering firm's graphics team over the course of a year.

PRODUCTIVITY TASK 3: RETURNING TO THE DESKTOP FROM A POWERED-OFF STATE

In our testing, we found that the newer laptops running Windows 10 and powered by 8th generation Intel Core vPro processors offered up to **1.4x faster performance** for system boots than did the 4th generation systems running Windows 10.

Note: The speed improvements seen in boot cycles on the newer systems might not result from the newer processors directly. These improvements might result from a number of different hardware or software differences, alone or in combination, on the newer systems. (As a reminder, our research focused on real-world performance gains for complete systems. It does not distinguish processor gains explicitly from gains due to other hardware or software components.)

BENEFITS TO A MEDIUM-SIZED COMPANY

Mobile employees, such as salespeople who make presentations on the road, tend to restart their computers frequently. Imagine, for example, that a salesperson for the engineering firm needs to present a video to a prospective client in which she is attempting to demonstrate the competency and reliability of the business. This perceived speed can either help or hurt sales, with a slow boot time potentially introducing awkwardness before a presentation that can erode rapport between the engineering firm's salesperson and her audience.

Table 3. Select productivity testing results (median times shown)

Creating videos with motion-path animations (testing results **here**)	
Windows® 10 on a 4th generation system	24 minutes 16 seconds
Windows 10 on newer system	14 minutes 37 seconds (1.6x faster)
Transcoding videos (testing results **here**)	
Windows 10 on a 4th generation system	2 hours 15 minutes 16 seconds
Windows 10 on newer system	58 minutes 48 seconds (2.3x faster)
Booting to a desktop (testing results **here**)	
Windows 10 on a 4th generation system	23 seconds
Windows 10 on newer system	16 seconds (1.4x faster)

Manageability Tasks

In our manageability testing, we found that using Intel vPro platform features could save an IT team significant time and operational costs. By taking advantage of devices powered by the Intel vPro platform and by using Intel® Active Management Technology, IT staff can remotely push software and firmware updates to all their clients out-of-band, without requiring any operating system on the remote client. This capability could help reduce time requirements and simplify device management for IT.

MANAGEABILITY TASK 1: DEPLOYING A FRESH INSTALLATION OF WINDOWS® 10 REMOTELY

Intel® Manageability Commander and Intel Active Management Technology enable IT administrators to remotely deploy software out of band. This capability provides a significant administrative advantage, enabling the possibility of deploying an operating system such as Windows 10 (through a disk image or through traditional installation) even to remote, bare-metal, or compromised systems. This requirement could arise, for example, after a ransomware or other malware attack that compromised the existing operating system.

In our testing, we were able to successfully use Intel Manageability Commander to connect to remote systems equipped with 8th generation Intel Core vPro processors and deploy a fresh image (an ISO file) containing Windows 10 to those machines. Without using Intel Active Management Technology, we needed to physically walk to each machine and deploy the image while seated in front of it.

BENEFITS TO A MEDIUM-SIZED COMPANY

Thanks to Intel Active Management Technology, the IT staff at our engineering firm would be able to remotely remediate a ransomware attack on a computer equipped with an 8th generation Intel Core vPro processor by connecting to it and applying a fresh operating system over the network. For a system without Intel Active Management Technology enabled and configured, the user would have to power down the computer, and the IT staff would have to drive to the remote office to apply a fresh operating system. If the remote office was too far to reach by car, the system would have to be mailed back to the IT department to be serviced. During this time waiting for the machine to wipe clean, the user would be unable to work on his or her machine. The remote-administration capabilities of Intel Core vPro processors could thus save hours or even days, not only for IT staff, but also for the user whose system is compromised.[2]

MANAGEABILITY TASK 2: APPLYING AN INTEL SOFTWARE UPDATE REMOTELY

Our testing showed that when it comes to applying a software update, as with the first manageability task, Intel Active Management Technology saves time and effort through its remote-management capabilities. This capability can be especially helpful in a help-desk scenario in which a software or firmware flaw has rendered a system inaccessible through a Remote Desktop connection.

We applied an Intel software update to all of our remote systems as part of our testing, operating under the assumption that a software incompatibility made the system inaccessible through other traditional means. To apply the software update remotely to systems without using Intel Active Management Technology, we needed to physically walk to each remote system and install the update while seated in front of the computer. For the systems that had Intel vPro platform features enabled, we were able to connect remotely and install the software via Intel Manageability Commander.[2]

Once connected to the remote systems via Intel Manageability Commander, installing the update took an average of 2 minutes and 15 seconds. As it turns out, this result was even faster than applying the same update *locally* to a 4th generation platform system equipped with Windows 10, without even including the additional time spent walking to the remote system.

BENEFITS TO A MEDIUM-SIZED COMPANY

Overall, the remote-management capabilities built into Intel Core vPro processors would greatly benefit our engineering firm by sparing its IT staff time and effort that it could better spend on other productive tasks. This advantage is especially pronounced when the client machine is rendered unusable because in this case, the lost time applies to both the IT staff and the user. Intel Active Management Technology, part of the Intel vPro platform, would enable the engineering firm to bring all of its clients within the scope of management, even when those client machines are bare-metal systems. This increased management efficiency can potentially amount to substantial cost savings over the lives of the devices.[6]

Table 4. Manageability testing results (median times shown)

Deploying a disk image remotely (testing results **here**)	
Windows® 10 on a 4th generation system without using Intel® vPro™ platform features	Undefined (potentially hours or days, depending on the time required to reach the remote machine)
Windows 10 on an 8th generation system with the Intel vPro platform	3 minutes 48 seconds
Applying an Intel software update remotely (testing results here)	
Windows 10 on a 4th generation system without using Intel vPro platform features	Undefined (potentially hours or days, depending on the time required to reach the remote machine)
Windows 10 on an 8th generation system with the Intel vPro platform	2 minutes 15 seconds

Security Tasks

IT teams need to detect and remove malware from clients when the clients become infected, which can be a time-consuming operation. They also need to implement solutions that help prevent security breaches, in addition to handling the fallout when these breaches do occur. Intel Core vPro processors, and all 6th generation and newer Intel Core processors, provide separate security enhancements that can help IT teams in this area. These security improvements combine to help prevent malware infection and help make computers more difficult to compromise, reducing the time that IT needs to spend remediating infected or compromised systems.

SECURITY TASK 1: PERFORMING MALWARE DETECTION

Intel® Threat Detection Technology (Intel® TDT) is a security feature that is available on all 6th generation and newer Intel Core vPro processors. Intel touts Intel TDT as an advanced malware-detection capability rooted in silicon-level protection.

One of the main features of Intel TDT is Advanced Memory Scanning (AMS). AMS offloads memory scanning for malware to the on-board Intel graphics processing unit (GPU), allowing a dramatically reduced impact to system performance.[7] In earlier systems, memory scanning was performed by the CPU, and the negative impact on system performance could induce many to disable the feature, which in turn could increase the risk for malware infection. Microsoft is integrating the AMS feature of Intel TDT into Windows 10 through Windows Defender Advanced Threat Protection (ATP).[8]

Another Intel TDT feature is Advanced Platform Telemetry. This feature makes use of cloud-based machine learning to help Intel processors spot advanced malware through signatures of unusual system activity.

Because Intel TDT is available only on 6th generation and later Intel Core processors, Windows 10 clients running on 4th generation systems are not able to benefit from this feature. Clients lacking the protection of Intel TDT are likely at a greater risk for malware infection.

BENEFITS TO A MEDIUM-SIZED COMPANY

For our engineering firm, the availability of Intel TDT on the newer systems would help ensure a higher level of worker productivity while crucial memory scans take place, which in turn allows more frequent memory scans and better malware protection overall. If the engineering firm were to upgrade to Windows 10 in place on systems based on 4th generation Intel Core processors, the IT staff might decide to reduce the frequency of memory scans because of the potential impact of scans on performance. Intel TDT would also help spot advanced threats missed by malware through the Advanced Platform Telemetry feature. Over time, the lack of these extra security protections could result in more frequent malware infections, possibly including expensive ransomware, which ultimately could lead to lost productivity and lost money for the firm.

Intel® Active Management Technology Helps Improve Security

The remote, out-of-band management capabilities of Intel Active Management Technology deliver important security improvements to consider. For example, Intel Active Management Technology offers a way to regain control of remote systems whose operating systems have been compromised, hijacked in a ransomware attack, or rendered inaccessible through malware.

SECURITY TASK 2: IMPLEMENTING STRATEGIES AGAINST IDENTITY THEFT

Identity theft is a growing problem among businesses, representing 65 percent of data breaches in the first half of 2018,[9] and it's expected to climb to a $6 trillion problem by 2021.[10] The Intel® Authenticate solution, part of the Intel vPro platform, helps protect against identity theft by enabling multi-factor authentication at the hardware level.

Software-based authentication, even when it is multi-factor authentication, could be vulnerable to attackers seeking to steal bits that will allow them to impersonate legitimate users. Armed with stolen credentials, these hackers can then inflict damage in various ways, such as by stealing or deleting vital company data or by holding company secrets hostage in a ransomware attack.

With Intel Authenticate, IT security teams can apply hardware-based, multi-factor authentication policies that combine two, three, or more factors, essentially locking these various credentials into a vault in silicon, where they are much less prone to theft.

Intel Authenticate is not available in 4th generation Intel Core vPro processors. However, in our testing of the 8th generation Intel Core vPro processor–based systems (which were equipped with fingerprint readers), we were able to apply a multi-factor security policy that relied on hardware-based fingerprint recognition, and then sign on to the computer quickly and easily.

BENEFITS TO A MEDIUM-SIZED COMPANY

Intel Authenticate, available in 8th generation Intel Core vPro processors, would allow the IT staff of our engineering firm to require employees to use hardware-based, multi-factor authentication on their Windows 10 machines. Such a policy would help provide a robust defense against identity theft. The cost of identity theft is hard to estimate, but if it did occur, it could result in stolen intellectual property or other problems that could threaten the engineering firm's business competitiveness or bottom line.

After a security breach, the engineering team's IT staff would need to spend considerable time and effort to determine what damage was caused by the breach and then repair that damage, if that would even be possible. The increased protection against identity theft would make Intel Authenticate an invaluable addition to the engineering firm's security strategy.

Conclusion

8th generation Intel Core vPro processors enable many advantages in productivity, manageability, and security that are not available through Windows 10 alone.

These advantages include:

- **Up to 1.6x better performance** in creating motion-path animations (test results **here**)
- **Up to 2.3x better performance** in transcoding videos (test results **here**), and performing financial calculations **up to 2.3x faster**[13]
- **Remote administration** out of band
- **Hardware-based security** features like multi-factor authentication

Organizations planning to migrate to Windows 10 should consider these significant advantages when deciding whether to upgrade their client machines in addition to the software. As they calculate the potential infrastructure costs of purchasing new devices, businesses should view that expenditure holistically and weigh it against the losses that could result from the lower productivity, slower and more complex manageability, and lower security of 4th generation systems.

Benchmark Testing by Intel Points to Productivity Gains on Newer Systems

Intel conducted its own testing that compared performance for a wide array of tasks on 4th generation and newer systems. This testing, while based on Intel reference platforms only, highlighted additional productivity gains on Windows® 10 clients powered by 8th generation Intel® Core™ processors (specifically Intel Core i7-8650U processors) compared to 4th generation Intel Core processors (specifically Intel Core i7-4600U processors).[11] For more information on this testing, you can visit **www.intel.com/benchmarks** and click "Show more" beneath the table of performance testing results.

MICROSOFT® POWER BI

Intel found that, among the many positive results from this testing, the newer systems allow workers to analyze and visualize data up to 40 percent faster using Power BI.[12] Specifically, the testing compared the performance in completing the Power BI data-source-change workload, a test which measures the time to load, query, and calculate statistics, and then draw six charts from a different local data source containing 2.2 million sales records.

CALCULATIONS IN MICROSOFT® EXCEL®

Intel also found that the newer systems performed finance calculations up to 2.3 times faster in Excel, as measured by the time to complete a large numerical calculation workload.[13] The specific workload tested was a spreadsheet that calculated the Put and Call option valuation for the Black-Scholes option pricing model using Monte Carlo simulation.

MULTITASKING

Next, the testing revealed up to a 2.1x gain in multitasking times, as measured by the performance of the Microsoft® Office productivity and multitasking workload.[14] This workload allows testers to register the time to complete multiple tasks simultaneously, including collaborating with team members using Slack®, creating a video presentation, creating PDF documents, and working with datasets in Excel.

OVERALL SYSTEM PERFORMANCE

Finally, the testing conducted by Intel revealed an improvement of up to 80 percent in overall system performance, as measured by the scores from the SYSmark® 2014 SE benchmark test.[15] This benchmark, which is made available by the BAPCo® consortium, measures the performance of Windows platforms in four usage scenarios: office productivity, media creation, data/financial analysis, and responsiveness.[16] (SYSmark contains real applications from ISVs such as Microsoft and Adobe.)

BENEFITS TO A MEDIUM-SIZED COMPANY

How might these improvements help a medium-sized company? We can imagine that our engineering firm's financial team uses Power BI and financial applications such as Excel to analyze data, present reports with visualizations, and make recommendations to senior management. For these professionals, the performance improvements observed on the newer systems in Power BI and financial calculations could reduce wait times in their core work, thus speeding the time to financial insights and improving company agility, along with team morale.

But the improvements shown in overall system performance and multitasking are even more significant because they affect essentially all workers in the business. Even if these performance improvements translate to merely 9 seconds of time saved per hour, for example, they would amount to 5 hours over the course of a 50-week work year per employee. And for a company of 200, those 9 seconds of saved time per hour resulting from faster financial calculations would add up to 1,000 hours of gained productivity per year.

Appendix 1: Testing Details Supporting Claim 1: "Systems Running Windows 10 on 8th Generation Intel Core vPro Processors Offer up to 1.6x Faster Performance over Systems Running Windows 10 on 4th Generation Intel Core vPro Processors in Creating Motion-Path Animations"

For the testing related to this claim, the following actions were timed on systems powered by both 4th generation Intel Core vPro processors and 8th generation Intel Core vPro processors:

- Launch the Autodesk® AutoCAD® application.
- Create a building design and save.

Software Prerequisites

- Software: AutoCAD version 23.0.46.0
- Mountain Lake House file

Testing Steps for Claim 1

1. Launch AutoCAD. (Start timing.)
2. From the ribbon, click **Open** (the folder icon).
3. Browse to the desktop, and then open the **Mountain Lake House** file.
4. Once the file is open, click **Management**, and then run the Action script called **ActMacro001**. This will draw a circle and start the animation screen. (End timing.)
5. In the **Camera** section, click the target icon with the default **Path** selection. Click the circle that was previously drawn. (Start timing.)
6. In the **Target** section, click the radial button for **Point**, click the target icon, and then click the plus symbol in the middle of the house.
7. Change the **Time** to **10 seconds**, the **Visual Style** to **Realistic**, and set the resolution to **1024x768**. (End timing.)
8. Click the **Start** button to start the animation rendering. (Start timing.)
9. Save the file to the desktop with the default name.
10. Once done, close AutoCAD. (End timing.)

Testing Results for Claim 1

Testing dates: October 19–29, 2018

(Testing results for Windows 7 Professional are provided below to support the claim, included in this report, that performance worsened for these same tasks on the 4th generation systems after the operating system was upgraded from Windows 7 to Windows 10.)

CREATE COMPLEX 3D GRAPHICS UP TO 1.6x FASTER			
Lenovo			
Device	Lenovo® ThinkPad® T440s	Lenovo ThinkPad T440s	Lenovo ThinkPad T480s
Processor	Intel® Core™ i7-4600U (4th gen)	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows® 7 Professional	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:20:51	0:23:56	0:13:52
HP			
Device	HP® EliteBook® Folio® 9480m	HP EliteBook Folio 9480m	HP EliteBook 840 G5
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 7 Professional	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:19:26	0:26:24	0:15:10
Dell			
Device	Dell™ Latitude™ E5440	Dell Latitude E5440	Dell Latitude 7290
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 7 Professional	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five run	0:18:21	0:22:29	0:14:49
Average for all three devices	0:19:33	0:24:16	0:14:37

MATHEMATICAL BASIS FOR CLAIM OF 1.6X PERFORMANCE IMPROVEMENT ON 8TH GENERATION PLATFORM

= Avg. for Windows 10 on 4th generation platform/avg. for Windows 10 on 8th generation platform

= 24:16/14:37 = 1,456 seconds/877 seconds

= **1.66x performance improvement**

Appendix 2: Testing Details Supporting Claim 2: "Systems Running Windows 10 on 8th Generation Intel Core vPro Processors Offer up to 2.3x Faster Performance over Systems Running Windows 10 on 4th Generation Intel Core vPro Processors in Transcoding Professional Videos"

For this test, the following action was timed on systems powered by 4th generation Intel Core vPro processors and 8th generation Intel Core vPro processors:

- Use HandBrake to transcode a video.

Software Prerequisites

- HandBrake 1.1.2
- The workload video file "tearsofsteel_4k.mov," available from **mango.blender.org**.

Software Description

HandBrake is a tool for converting video from nearly any format to a selection of modern, widely supported codecs. For more information, visit the official HandBrake website at **www.handbrake.fr**.

TEST WORKLOAD DESCRIPTION

The workload video file, "tearsofsteel_4k.mov," is an .mov video file that is about 6.27 GB, 3840 x 1714, 73.4 Mbps, 24 frames per second (fps), H.264, and that is transcoded to an .mkv video file that is about 1920 x 1080, 3.5 Mbps, 24 fps, HEVC.

Testing Steps for Claim 2

1. Launch HandBrake.
2. Click **File** > **Open a single video file**, and then select the workload file.
3. At the bottom of the window, specify a destination path for the output in the **Save As** field.
4. In the **Presets** pane on the right, under **Matroska**, select **H.265 MKV 1080p30**.
5. In the **Video** tab:
    a. Set **Video Codec** to **H.265 (Intel QSV)**.
    b. Set the **Framerate (FPS)** to **Same as source**, and then select **Constant Framerate**.
    c. Set the **Encoder Profile** to **Main**.
    d. Set the **Encoder Level** to **4.0**.
    e. Set the **Quality** to **Avg Bitrate (kbps): 3456**.
6. Click **Start Encode**. Encoding progress is displayed at the bottom of the window.
7. When the task is finished, the final results are recorded in the log file.
8. In the top menu bar, click **Activity Log**.

9. Scroll to the bottom of the Log Viewer. The last line should read **# Encode Completed ….**
10. Find the line that says **encoded xxxxx frames in xxx.xxx s (xx.xx fps), xxxx.xx kb/s, Avg QP:xx.xx**, a few lines from the bottom. Record the elapsed time in seconds as your result. (The timed result captures the seconds it took to encode the video.)
11. Close HandBrake.
12. Locate and delete the output video file.

Testing Results for Claim 2

Testing dates: October 15–31, 2018

UP TO 2.3x BETTER PERFORMANCE TRANSCODING PROFESSIONAL VIDEOS		
Lenovo		
Device	Lenovo® ThinkPad® T440s	Lenovo ThinkPad T480s
Processor	Intel® Core™ i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows® 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	2:23:21	0:52:57
HP		
Device	HP® EliteBook® Folio® 9480m	HP EliteBook 840 G5
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	2:14:52	0:59:27
Dell		
Device	Dell™ Latitude™ E5440	Dell Latitude 7290
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	2:07:35	1:03:59
Average for all three devices	2:15:16	0:58:48

MATHEMATICAL BASIS FOR CLAIM OF 2.3X PERFORMANCE IMPROVEMENT ON 8TH GENERATION PLATFORM

= Avg. for Windows 10 on 4th generation platform/avg. for Windows 10 on 8th generation platform

= 2:15:16/0:58:48 = 8,116 seconds/3,528 seconds

= **2.33x performance improvement**

Appendix 3: Testing Details Supporting Claim 3: "Systems Running Windows 10 on 8th Generation Intel Core vPro Processors Offer up to 1.4x Faster Performance over Systems Running Windows 10 on 4th Generation Intel Core vPro Processors for System Boots"

The following actions were timed on systems with both 4th generation Intel Core vPro processors and 8th generation Intel Core vPro processors:

- Get to the logon prompt from a cold state.
- Get to the desktop from the Windows logon prompt by entering a password.

(Testing was performed separately for these two actions. Timed results were then added together to determine the overall boot times.)

Testing Results for Claim 3.1

Get to the logon prompt from a cold state:

1. Ensure that the mobile device is in a powered off cold state.
2. Turn on the mobile device. (Start timing.)
3. Wait for the logon prompt to appear. (End timing.)

Testing Results for Claim 3.1

Testing dates: September 25–October 29, 2018

STEP 1: GETTING TO THE LOGON PROMPT FROM A COLD STATE		
Lenovo		
Device	Lenovo® ThinkPad® T440s	Lenovo ThinkPad T480s
Processor	Intel® Core™ i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows® 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:00:11	0:00:19
HP		
Device	HP® EliteBook® Folio® 9480m	HP EliteBook 840 G5
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:00:25	0:00:12
Dell		
Device	Dell™ Latitude™ E5440	Dell Latitude 7290
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:00:21	0:00:12
Average for all three devices (test 3.1)	0:00:19	0:00:14

Testing Steps for Claim 3.2

Get to the desktop from the Windows logon prompt by entering a password:

1. From the start screen, log on to Windows by entering a password. (Start timing.)
2. Wait for the Windows desktop to appear. (End timing.)

Testing Results for Claim 3.2

Testing dates: September 25–October 29, 2018

STEP 2: GET TO A DESKTOP FROM THE WINDOWS LOGON PROMPT BY ENTERING A PASSWORD		
Lenovo		
Device	Lenovo® ThinkPad® T440s	Lenovo ThinkPad T480s
Processor	Intel® Core™ i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows® 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:00:04	0:00:03
HP		
Device	HP® EliteBook® Folio® 9480m	HP EliteBook 840 G5
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:00:04	0:00:02
Dell		
Device	Dell™ Latitude™ E5440	Dell Latitude 7290
Processor	Intel Core i7-4600U (4th gen)	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time to complete testing steps after five runs	0:00:04	0:00:02
Average for all three devices (test 3.2)	0:00:04	0:00:02

SUM OF AVERAGE TIMES FOR TEST 3.1 (COLD STATE TO LOGON) AND TEST 3.2 (LOGON TO DESKTOP)		
	4th Generation Platform Systems	8th Generation Platform Systems
Average time for all devices (test 3.1)	0:00:19	0:00:14
Average time for all devices (test 3.2)	0:00:04	0:00:02
Average time for all devices (test 3.1 + test 3.2)	0:00:23	0:00:16

MATHEMATICAL BASIS FOR CLAIM OF 1.4X PERFORMANCE IMPROVEMENT ON 8TH GENERATION PLATFORM

= Total time (avg.) for Windows 10 on 4th generation platform/total time (avg.) for Windows 10 on 8th generation platform

= 00:23 seconds/00:16 seconds

= **1.43x performance improvement**

Appendix 4: Testing Details Supporting Claims About Remotely Deploying a Disk Image with Windows 10

This paper makes the claim that using Intel Manageability Commander to deploy a disk image including Windows 10 on a remote system powered by an 8th generation Intel Core vPro processor took 3 minutes 48 seconds on average. For the testing related to this claim, the following steps were timed (with all user-interaction time deducted from the total measurement).

Testing Steps for Claim 4

Deploy Windows 10 via an ISO image to a remote computer powered by an 8th generation Intel Core vPro processor:

1. Launch Intel Manageability Commander.
2. Click **File** > **Add Computer**.
3. Enter the **Hostname/FQDN** in the appropriate field.
4. Enter an **Alias** if needed.
5. Browse to the .iso image on the admin machine.
6. Select **Power**.
7. Select **Reset to IDE-R Image**.
8. From Windows Setup, click **Next**. (Start timing.)
9. Click **Install Now**.
10. At the Activate Windows screen, select **I don't have a product key**, and then click **Next**.
11. Read the applicable notices and license terms, select **I accept the license terms**, and then click **Next**.
12. From the **Which type of installation do you want** screen, select **Custom (advanced)**.
13. Select the **Primary partition** to install Windows 10 Pro, and click **Next**. (End timing.)
14. At the **Let's start with region screen**, click **Yes**. (Start timing.)
15. At the **Is this the right keyboard layout screen**, click **Yes**.
16. When asked if you want to add a second keyboard layout, click **Skip**.
17. At the **How would you like to setup** screen, select **Set up for an organization**, and then click **Next**.
18. Sign in with Microsoft, and then select **Domain join instead**.
19. At the **Who's going to use this PC** screen, enter **User,** and then click **Next**.
20. Enter a password, and then click **Next**.
21. Confirm your password, and then click **Next**.
22. For **Security Question 1**, select the first question, enter a response, and then click **Next**.
23. For **Security Question 2**, select the first question, enter a response, and then click **Next**.
24. For **Security Question 3**, select the first question, enter a response, and then click **Next**.
25. At the Make Cortana your personal assistant screen, select **Yes**.
26. At the **Choose privacy settings for your device** screen, click **Accept**. (End timing.)
27. Log on using administrator credentials.
28. Click **Start**. (Start timing.)
29. Search for **Domain**.
30. Select **See organization or workgroup for this PC**.
31. Search for **Domain**.
32. Select **Set up a work or school account**.

33. Select **Join this device to a local Active Directory Domain**.
34. Enter a domain.
35. Enter administrator credentials, and then click **OK**.
36. At the **Welcome to the domain** screen, click **OK**.
37. Click **Restart Now**. (End timing.)
38. Log on after reboot. (Timed.)

Testing Results for Claim 4

Testing date: October 15, 2018

DEPLOY AN ISO IMAGE CONTAINING WINDOWS® 10 TO A REMOTE COMPUTER	
Lenovo	
Device	Lenovo® ThinkPad® T480s
Processor	Intel® Core™ i7-8650U (8th gen)
Operating system	Windows® 10 Pro
Median time to complete testing steps after five runs	0:03:55
HP	
Device	HP® EliteBook® 840 G5
Processor	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro
Median time to complete testing steps after five runs	0:03:55
Dell	
Device	Dell™ Latitude™ 7290
Processor	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro
Median time to complete testing steps after five runs	0:03:34
Average for all three devices	0:03:48

Appendix 5: Testing Details Supporting Claims About Applying an Intel Software Update Remotely

This paper makes two claims about applying an Intel software update remotely. The first claim is that using Intel Manageability Commander to install a software update on a remote system powered by an 8th generation Intel Core vPro processor took an average of only 2 minutes and 15 seconds. The second claim is that this result was faster than applying the same Intel update locally to a system running Windows 10 and powered by a 4th generation Intel Core processor.

For the testing related to these claims, the following actions were timed:

- Remotely connect to a system powered by an 8th generation Intel Core vPro processor by using Intel Manageability Commander and then update the firmware for the device.
- Physically log on to a local system powered by a 4th generation Intel Core processor and then update the firmware for the device.

Testing Steps for Claim 5.1

Remotely connect to a system powered by an 8th generation Intel Core vPro processor by using Intel Manageability Commander and then update the firmware for the device:

1. Launch Intel Manageability Commander.
2. Click **File** > **Add Computer**.

3. Enter the **Hostname/FQDN** in the appropriate field.
4. Enter an **Alias** if needed.
5. Connect to **Remote Desktop**.
6. Launch Internet Explorer. (Start timing.)
7. Browse to **https://downloadcenter.intel.com/download/28240/Intel-Graphics-Driver-for-Windows-10**.
8. Select **win64_15.40.41.5058.exe.**
9. Click **Save File**
10. Click **Run**. (End timing.)
11. Restart the device.

Testing Results for Claim 5.1

Testing dates: October 23–November 5, 2018

APPLY AN INTEL® SOFTWARE UPDATE TO A REMOTE COMPUTER BY USING INTEL® MANAGEABILITY COMMANDER	
Lenovo	
Device	Lenovo® ThinkPad® T480s
Processor	Intel® Core™ i7-8650U (8th gen)
Operating system	Windows® 10 Pro
Median time to complete testing steps after five runs	0:02:22
HP	
Device	HP® EliteBook® 840 G5
Processor	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro
Median time to complete testing steps after five runs	0:01:54
Dell	
Device	Dell™ Latitude™ 7290
Processor	Intel Core i7-8650U (8th gen)
Operating system	Windows 10 Pro
Median time to complete testing steps after five runs	0:02:29
Average for all three devices	0:02:15

Testing Steps for Claim 5.2

Physically log on to a local system powered by a 4th generation Intel Core processor and then update the firmware for the device:

1. Launch Internet Explorer. (Start timing.)
2. Browse to **https://downloadcenter.intel.com/download/28165/Intel-Graphics-Driver-for-Windows-7-8-1-15-36-?product=76616**.
3. Select **win64_15.40.41.5057.exe**.
4. Click **Save File**.
5. Click **Run**. (End timing.)
6. Restart the device.

Testing Results for Claim 5.2

Testing dates: October 23–November 5, 2018

APPLY AN INTEL® SOFTWARE UPDATE TO A LOCAL COMPUTER POWERED BY A 4TH GENERATION INTEL® CORE™ PROCESSOR.	
Lenovo	
Device	Lenovo® ThinkPad® T440s
Processor	Intel® Core™ i7-4600U (4th gen)
Operating system	Windows® 10 Pro
Median time to complete testing steps after five runs	0:02:49
HP	
Device	HP® EliteBook® Folio® 9480m
Processor	Intel Core i7-4600U (4th gen)
Operating system	Windows 10 Pro
Median time to complete testing steps after five runs	0:02:13
Dell	
Device	Dell™ Latitude™ E5440
Processor	Intel Core i7-4600U (4th gen)
Operating system	Windows 10 Pro
Median time to complete testing steps after five runs	0:02:17
Average for all three devices (test 5.2)	0:02:26

[1] Software and workloads used in performance tests may have been optimized for performance only on Intel® microprocessors. Performance tests, such as SYSmark® and MobileMark®, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

[2] The 4th generation Intel® processors tested in our study did include the Intel® vPro™ platform. However, many enterprise clients do not include this technology. In our testing, we sought to determine the manageability improvements that an enterprise would experience if it acquired Intel vPro platforms on its clients for the first time

[3] Software and workloads used in performance tests may have been optimized for performance only on Intel® microprocessors. Performance tests are measured using specific computer systems, components, software, operations, and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. No computer system can be absolutely secure.

[4] The speed improvements seen in boot cycles on the newer systems may or may not result from the newer processors directly. These improvements might result from a number of different hardware or software differences, alone or in combination, on the newer systems.

[5] The slower average performance in Windows® 10 on the 4th generation systems could have resulted from the fact that the operating system was upgraded in place. Windows 10 was not installed fresh. The in-place upgrade could result in slower storage performance.

[6] Intel. Intel® vPro™ Platform TCO Estimator. **http://estimator.intel.com/vpro/**.

[7] Intel. "Intel® Threat Detection Technology (Intel® TDT)." 2018. **www.intel.com/content/dam/www/public/us/en/documents/product-briefs/tdt-product-brief.pdf**.

[8] Intel. "Securing the Digital World: Intel Announces Silicon-Level Security Technologies, Industry Adoption at RSA 2018." April 2018. **https://newsroom.intel.com/editorials/securing-digital-world-intel-announces-silicon-level-security-technologies-industry-adoption-rsa-2018/#gs.drujX3UV**.

[9] Statista. "Distribution of global data breach incidents in 1st half 2018, by type." **www.statista.com/statistics/329593/frequency-share-incident-classifiaction-patterns/**.

[10] Steve Morgan. "Is cybercrime the greatest threat to every company in the world?" CSO from IDG. July 2017. **www.csoonline.com/article/3210912/security/is-cybercrime-the-greatest-threat-to-every-company-in-the-world.html**.

[11] **Configurations based on Intel testing as of 2018**: Old system: Intel® Core™ i7-4600U processor PL1=15WTDP, two cores, four threads, Intel® Turbo Boost Technology enabling up to 3.3 GHz, Intel reference platform, graphics: Intel® HD Graphics 4400, memory: 2 x 4 GB DDR3-1600, storage: Intel® SSD 540s, BIOS version 139 with MCU 0x23, operating system: Windows® 10 (version 10.0.16299.192). Newer system: Intel Core i7-8650U processor PL1=15WTDP, four cores, eight threads, Intel Turbo Boost Technology enabling up to 4.2 GHz, Intel Reference Platform, graphics: Intel® UHD Graphics 620, memory: 2 x 4GB DDR4-2400, storage: Intel SSD Pro 6000p, BIOS version 117.07 with MCU 0x84, operating system: Windows 10 (version 10.0.16299.192). For more details, see **www.intel.com/benchmarks**.

[12] **Configurations based on Intel testing as of 2018**. "40-percent faster" claim as measured by Microsoft® Power BI data-source change workload comparing an 8th generation Intel® Core™ i7-8650U processor against a 4th generation Intel Core i7-4600U processor using an Intel reference platform. For more details, see **www.intel.com/benchmarks**.

[13] **Configurations based on Intel testing as of 2018**. "2.3 times faster" claim as measured by large numerical calculation workload comparing an 8th generation Intel® Core™ i7-8650U processor against a 4th generation Intel Core i7-4600U processor.

[14] **Configurations based on Intel testing as of 2018**. "2.1 times gain in multitasking times" claim as measured by Office Productivity and Multitasking Workload on Intel Reference Platform comparing an 8th generation Intel® Core™ i7-8650U processor against a 4th generation Intel Core i7-4600U processor using an Intel reference platform. For more details, see **www.intel.com/benchmarks**.

[15] **Configurations based on Intel testing as of 2018**. "Up to 80 percent in overall system performance" claim as measured by the SYSmark® 2014 SE benchmark test comparing an 8th generation Intel® Core™ i7-8650U processor against a 4th generation Intel Core i7-4600U processor using an Intel reference platform. For more details, see **www.intel.com/benchmarks**.

[16] Intel is a member of the BAPCo® consortium.

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Performance results are based on testing by Prowess Consulting between September 25, 2018, and November 5, 2018, and may not reflect all publicly available security updates. See configuration disclosure for details. No product or component can be absolutely secure.

The analysis in this document was done by Prowess Consulting and commissioned by Intel.

Results have been simulated and are provided for informational purposes only. Any difference in system hardware or software design of configuration may affect actual performance.

Cost reduction scenarios described are intended as examples of how a given product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Prowess and Intel do not guarantee any costs or cost reduction.

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