![PROWESS]

Newer Client Devices Powered by 8th Generation Intel® Core™ vPro® Processors Deliver Big Benefits

Newer mobile PCs help bring advantages in productivity, manageability, and security.

Executive Summary

IT departments for medium-sized companies face constant pressure to do more with less, given their limited IT budgets. Some businesses might try to stretch their IT dollars by extending the lives of the older PCs their workers use on a daily basis. But three-year-old (and older) devices can lack the performance, security, manageability, and stability enabled by modern PCs built on newer Intel® Core™ vPro® processors, running Windows® 10. Is it worth the trade-off for organizations to keep using outdated devices, despite the likely benefits offered by newer PCs?

To help organizations make an informed decision, Prowess Consulting conducted testing that compared the performance and capabilities of Windows 10 running on three-year-old devices, powered by 6th Generation Intel Core vPro processors, to newer devices, powered by the latest 8th Generation Intel Core vPro processors. We ran real-world tests, which go beyond industry-standard benchmarking, by running workloads common to modern workers.

Our investigation pointed to a clear answer.[1] Windows 10 devices that are powered by the Intel vPro® platform and 8th Generation Intel Core i7 vPro processors show significant benefits across a number of areas compared to Windows 10 devices powered by three-year-old, 6th Generation Intel Core i7 vPro processors ("6th generation systems"). For full testing configurations and procedures, see the **appendices** of this report.

Performance

Gain up to **65% improvement** in overall performance

Security

Greater peace of mind through Intel® Hardware Shield, which provides protection below the operating system

Manageability

Remotely troubleshoot through Intel® Endpoint Management Assistant (Intel® EMA), which provides out-of-band cloud-based device management

Productivity

Enhance productivity with up to **1.53x faster** video transcoding

Does It Pay to Refresh Three-Year-Old Client Systems?

Medium-sized companies are weighing two different strategies. Is it better to extend the working life of their three-year-old (and older) devices, or is it wiser to refresh their older client computers to newer, more efficient models?

Extending the life of existing hardware might seem like a more affordable strategy in the short term, but this option also comes with some significant downsides:

- 6th generation systems can require more time to complete tasks that are critical to the daily workflow for workers, potentially hindering productivity.

- 6th generation systems are unable to take advantage of Intel® Optane™ technology to improve system responsiveness, especially for heavy computational workloads.

- 6th generation systems do not have the security features and manageability that 8th Generation Intel Core vPro processor–based computers do.

To help businesses assess the benefits of refreshing their client PCs, we conducted testing that compared the performance and capabilities of Windows 10 running on 6th Generation Intel Core vPro processor–based systems to 8th Generation Intel Core vPro processor–based systems.

6th Generation vs. 8th Generation Devices Tested

In our testing, we completed several real-world tasks that are commonly performed by workers at medium-sized companies. We performed the same tasks on six different systems:

1. Three-year-old system 1:
    - Model: Dell™ Latitude™ E5470
    - CPU: 6th Generation Intel Core i7-6600U processor
2. Three-year-old system 2:
    - Model: HP® EliteBook® 840 G3
    - CPU: 6th Generation Intel Core i7-6600U processor
3. Three-year-old system 3:
    - Model: Lenovo® ThinkPad® T470s
    - CPU: 6th Generation Intel Core i7-6600U processor
4. Newer system 1:
    - Model: Dell Latitude 7400
    - CPU: 8th Generation Intel Core i7-8665U processor
5. Newer system 2:
    - Model: HP EliteBook 830 G6
    - CPU: 8th Generation Intel Core i7-8665U processor
6. Newer system 3:
    - Model: Lenovo ThinkPad T590
    - CPU: 8th Generation Intel Core i7-8665U processor

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

Table 1. 6th generation systems used in testing

6th Generation Intel® Core™ vPro® i7 processor–based systems

Device	Dell™ Latitude™ E5470	HP® EliteBook® 840 G3	Lenovo® ThinkPad® T470s
Processor	Intel Core i7-6600U processor	Intel Core i7-6600U processor	Intel Core i7-6600U processor
Intel vPro® Platform Eligibility	Yes	Yes	Yes
Model Number	E5740	840 G3	T470s
Storage	Intel® SSD 760p (512 GB, M.2 80mm, PCIe 3.0 x4, 3D2, TLC)	Intel SSD 760p (512 GB, M.2 80mm, PCIe 3.0 x4, 3D2, TLC)	Intel SSD 760p (512 GB, M.2 80mm, PCIe 3.0 x4, 3D2, TLC)
Memory	8 GB (1 x 8 GB DDR4 2,133 MHz)	8 GB (1 x 8 GB DDR4 2,133 MHz)	8 GB (1 x 8 GB DDR4 2,133 MHz)
Graphics	Intel® HD Graphics 520	Intel HD Graphics 520	Intel HD Graphics 620
Operating System	Windows® 10 Pro RS5 build version 1809 (build 1763v292)	Windows 10 Pro RS5 build version 1809 (build 1763v292)	Windows 10 Pro RS5 build version 1809 (build 1763v292)
BIOS	Dell Inc. 1.21.4, 6/25/2019	HP N75 ver. 0.1.39, 4/16/2019	Lenovo N1WET54W (1.33), 4/17/2019

Table 2. 8th generation systems used in testing

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

Device	Dell™ Latitude™ 7400	HP® EliteBook® 830 G6	Lenovo® ThinkPad® T590
Processor	Intel Core i7-8665U processor	Intel Core i7-8665U processor	Intel Core i7-8665U processor
Intel vPro® Platform Eligibility	Yes	Yes	Yes
Model Number	7400	830 G6	T590
Storage	Intel® SSD 760p (512 GB, M.2 80mm, PCIe 3.0 x4, 3D2, TLC)	Intel SSD 760p (512 GB, M.2 80mm, PCIe 3.0 x4, 3D2, TLC)	Intel SSD 760p (512 GB, M.2 80mm, PCIe 3.0 x4, 3D2, TLC)
Memory	8 GB (1 x 8 GB DDR4 2,666 MHz)	8 GB (1 x 8 GB DDR4 2,666 MHz)	16 GB (1 x 16 GB DDR4 2,400 MHz)
Graphics	Intel® UHD Graphics 620	Intel UHD Graphics 620	Intel UHD Graphics 620
Operating System	Windows® 10 RS5 build version 1809 (build 1763v1)	Windows 10 RS5 build version 1809 (build 1763v1)	Windows 10 RS5 build version 1809 (build 1763v1)
BIOS	Dell Inc. 1.3.11, 6/11/2019	HP R70 Ver. 01.01.06, 5/14/2019	Lenovo N2IET71W (1.49), 7/3/2019

Typical Tasks Compared

Our testing revealed significantly better productivity, security, and manageability capabilities in the devices powered by 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 6th generation systems running the same operating system:

- Creating motion-path animations: Up to 1.24x faster performance (see **Appendix 1**)[1]
- Transcoding videos: Up to 1.53x faster performance (see **Appendix 2**)[1]
- Booting to a desktop: Up to 1.41x faster performance (see **Appendix 3**)[1,2]

User-Based Testing

In the following sections, we summarize our testing results and discuss how they might affect a typical medium-sized business. To portray a realistic scenario, we present this medium-sized business as a multi-branch engineering firm employing 450 people.[3] Our fictional engineering company creates manufacturing parts and is distributed across three offices. The company also has sales representatives that travel and work from remote locations on the road.

Performance and 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 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.

Task 1: Create a Motion-Path Animation

According to our testing, an 8th Generation Intel Core vPro processor performs up to 1.24 times faster at creating a motion-path animation than does a 6th generation system with Windows 10 (see **Appendix 1**). The productivity gains averaged 2 minutes and 40 seconds of saved time per video.

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.[3] For businesses such as these that rely on creating videos with motion-path animations as part of their core services, an up to 1.24x 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 five hours of saved time* per year (2 minutes 40 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 its 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 when running mission-critical workloads on Windows 10.

Task 2: Transcoding Videos

In our testing, we found that our fictional engineering company could save up to 30 minutes 26 seconds 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 6th Generation Intel Core vPro processor. (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.[3] 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 *12 hours of saved time* (30 minutes 26 seconds time saved x 2 per month x 12 months) for the engineering firm's graphics team over the course of a year.

Task 3: Returning to the Logon Prompt 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 1.41 times faster performance for system boots than did the 6th generation systems running Windows 10.[2]

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 did 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.[3] This perceived speed difference—even when actually just a few seconds longer—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.

In addition, multiple restarts over the course of a week or year can add up. A difference of five seconds per restart, multiplied by 10 restarts a week, adds up to more than 41 minutes of wasted time over the course of a 50-week work year, per employee. Multiply that total by the 450 employees in our medium-sized business scenario, and it adds up to more than 312 lost hours per year. Even just one restart per employee per work day (five per week) would add up to more than 156 hours of lost productivity for the company over the course of the year.

Table 3. Select productivity testing results (average times for combined results from tested devices)

Creating motion-path animations	
Windows® 10 on a 6th generation system	12 minutes and 49 seconds
Windows 10 on a newer system	10 minutes and 18 seconds (1.24x faster)
Transcoding videos	
Windows 10 on a 6th generation system	1 hour, 26 minutes, and 53 seconds
Windows 10 on a newer system	56 minutes and 27 seconds (1.53x faster)
Booting to a login screen	
Windows 10 on a 6th generation system	17 seconds
Windows 10 on a newer system	12 seconds (1.41x faster)

Security and Management with the Intel vPro® Platform

Newer systems built on 8th Generation Intel Core vPro processors benefit from several new security and manageability features that Intel touts for helping lock down security and improving remote manageability. We took a closer look at these new features to see how they might benefit businesses considering an upgrade to newer systems.

Helping Protect the System at Start-Up with Intel® Hardware Shield

Windows 10 offers a range of security features designed to help make the operating system more secure against traditional software-based attacks. But modern cyber threats focus on deeper levels of the system, below the operating system.

Systems built on 8th Generation Intel Core vPro processors include a new security technology called **Intel® Hardware Shield** that can help IT admins strengthen device security without the need for additional IT infrastructure. Intel Hardware Shield helps ensure that the operating system is running on legitimate hardware, and it helps provide hardware-to-software security visibility by providing out-of-the-box platform protection from firmware attacks.

According to Intel, Intel Hardware Shield helps reduce the risk that a bug or vulnerability in firmware could be used to inject malicious code into the platform at runtime and hide that code from traditional antivirus solutions. Intel Hardware Shield also complements operating system–based and other software-based anti-malware solutions to help protect machines from start-up to operating system and application launches.

In addition, Intel Hardware Shield exceeds the standards set by the Microsoft secured-core PC initiative that combines an industry-standard hardware root of trust with security capabilities built into CPUs on compliant devices. In fact, nearly all the secured-core compliant devices **listed by Microsoft** are powered by Intel processors.[4]

Benefits to a Medium-Sized Company

Intel Hardware Shield uses technology that helps prevent firmware and critical data structures from being modified at runtime. This unique protection is effective and working out of the box, from the moment the Intel vPro platform is powered, with no IT infrastructure or setup required.

For a medium-sized business, this added level of protection offers significant benefits.[3] Malware attacks can compromise sensitive company and customer data, leading to downtime, legal costs, and damaged reputation. In addition, when a PC is compromised by malware at the BIOS level, it can be time-consuming for IT admins to remediate. When the infected device is at a remote location, that problem is compounded by the additional time required to ship the device to headquarters for servicing or to remotely remediate the PC.

The most effective way to reduce remediation impact is through prevention. Intel Hardware Shield adds a deeper level of protection that helps reduce or eliminate a vulnerable attack surface otherwise available to bad actors.

Managing Remote PCs with Intel® Active Management Technology (Intel® AMT) and Intel® Endpoint Management Assistant (Intel® EMA)

Several Intel vPro platform features can save an IT team significant time and operational costs. For example, by taking advantage of devices powered by the Intel vPro platform and by using Intel® Active Management Technology (Intel® AMT), 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 can be especially helpful in help-desk scenarios in which software or firmware flaws render systems inaccessible through a remote desktop connection.

Devices powered by 6th Generation and 8th Generation Intel Core vPro processors support Intel AMT, but only newer 8th Generation Intel Core vPro processor–based devices include a new feature—Intel® Endpoint Management Assistant (Intel® EMA). Intel EMA extends the benefits of Intel AMT by adding the ability to, over the cloud, remotely and securely connect Intel AMT devices inside and outside the corporate firewall.

With Intel EMA, IT users can integrate Intel AMT access into custom or third-party consoles. The managed devices can reside in the cloud, whether in a public or private network, and the console can reside in a private network, at the edge, or in the public cloud. With Intel EMA and Intel AMT, IT can use, deploy, and manage devices when in-band management is not sufficient or when the host operating system is non-responsive. For example, IT can reboot devices whose operating systems have hung or crashed.

Extend the Reach of Endpoint Management

Intel® Endpoint Management Assistant (Intel® EMA):

- Adds cloud-based endpoint management for Intel® Active Management Technology (Intel® AMT)
- Addresses Intel AMT configuration and use-case scenarios, such as client devices not on an intranet or on a home network
- Lowers the cost of endpoint operations through both in-band and out-of-band remote management

Benefits to a Medium-Sized Company

Suppose a sales rep from the engineering firm falls victim to a ransomware attack that blocks her from accessing her computer.[3] After quickly configuring Intel AMT with Intel EMA, the IT security staff at our engineering firm would be able to remotely remediate the computer through the cloud, even though it is only accessible over a public network and behind a corporate firewall. Because the remote device is equipped with an 8th Generation Intel Core vPro processor, the IT admin can connect to it and apply a fresh operating system.

For a system without Intel AMT enabled and configured, the user would have to shut down the computer and ship it 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 her device. 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.

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 AMT, 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 could amount to substantial cost savings over the lives of the devices.[5]

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 6th 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 i7-8665U processors) compared to 6th Generation Intel Core processors (specifically Intel Core i7-6600U processors).[6] For more information on this testing, you can visit **www.intel.com/benchmarks**, click **Performance Claims**, and then click **Show more** beneath the table of performance testing results. Scroll down or search for "2 in 1s, Y and U Series" in the device column.

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 1.5x faster using Microsoft Power BI.[6,7] Specifically, the testing compared the performance in completing the Power BI data-source-change workload, a test that 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.

Multitasking

Next, the testing revealed up to a 1.3x gain in multitasking times, as measured by the performance of the Microsoft® Office Productivity and Multitasking workload.[6,8] This workload allows testers to register the time to complete multiple tasks simultaneously, including exporting a Microsoft® Word document as a PDF, exporting a PDF file as a video, and performing a Microsoft® Excel® spreadsheet calculation.

Web Performance

Intel testing also revealed up to 55 percent better web performance, as measured by the Principled Technologies® WebXPRT 3 benchmark, which measures the performance of web applications using six usage scenarios: photo enhancements, organizing an album using artificial intelligence (AI), stock option pricing, encrypting notes and optical character recognition (OCR) scans, sales graphs, and online homework.[6,9] WebXPRT tests modern browser technologies, such as HTML5 Canvas 2D, HTML5 tables, HTML5 local storage, and JavaScript®.

Benchmark Testing by Intel Points to Productivity Gains on Newer Systems (Continued)

Overall System Performance

Finally, the testing conducted by Intel revealed an improvement of up to 65 percent in overall system performance, as measured by the scores from the SYSmark® 2018 benchmark test.[6,10] This benchmark, which is made available by the BAPCo® consortium, measures the real-world performance of Windows desktop applications in three usage scenarios: productivity, creativity, and responsiveness.[11] (SYSmark contains real applications from ISVs such as Microsoft, Adobe, and Google.)

Benefits to a Medium-Sized Company

How might these improvements help a business? 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.[3] 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.

Conclusion

8th Generation Intel Core vPro processors enable many advantages in productivity, security, and manageability for Windows 10 that are not available to older devices based on 6th Generation Intel Core vPro processors.

These advantages include:

- **Up to 1.24x better performance** in creating motion-path animations
- **Up to 1.53x better performance** in transcoding videos
- **Up to 1.41x faster** system start-up times
- **Advanced hardware-based security** features like Intel Hardware Shield
- **Easier administration** of remote, out-of-band devices with Intel AMT and Intel EMA

Organizations planning to migrate to Windows 10 should consider these significant advantages when deciding whether to upgrade their client machines. 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, lesser security, and slower and more complex manageability of 6th generation systems.

Appendix 1

Testing Details Supporting Claim 1: "Systems Running Windows 10 on 8th Generation Intel Core vPro Processors Offer up to 1.24x Faster Performance over Systems Running Windows 10 on 6th 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 6th 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.
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.
5. In the **Camera** section, click the target icon with the default **Path** selection. Click the circle that was previously drawn.
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**, change the **Visual Style** to **Realistic**, and set the resolution to **1024x768**. Click **OK**.
8. In the **Save As** dialog box, leave the default name in the **File name** field, and then click **Save**. (Start timing.)
9. Wait for rendering to complete. (End timing.)
10. Close AutoCAD.

Testing Results for Claim 1

Testing dates: September 2019

UP TO 1.24x FASTER PERFORMANCE CREATING MOTION-PATH ANIMATIONS		
Lenovo		
Device	Lenovo® ThinkPad® T470s	Lenovo ThinkPad T590
Processor	Intel® Core™ i7-6600U processor (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows® 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	00:11:47	00:11:12
HP		
Device	HP® EliteBook® 840 G3	HP EliteBook 830 G6
Processor	Intel Core i7-6600U processor (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	00:13:09	00:10:17
Dell		
Device	Dell™ Latitude™ E5470	Dell Latitude 7400
Processor	Intel Core i7-6600U	Intel Core i7-8665U processor (8th generation)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	00:13:30	00:09:25
Average time (hours:minutes:seconds) for all three devices	**00:12:49**	**00:10:18**

Mathematical Basis for Claim of 1.24x Performance Improvement on 8th Generation Platform

= Avg. for Windows 10 on 6th Generation Intel Core vPro processor–based system/avg. for Windows 10 on 8th Generation Intel Core vPro processor–based system

= 12:49/10:18 = 769 seconds/618 seconds

= **1.24x performance improvement**

Appendix 2

Testing Details Supporting Claim 2: "Systems Running Windows 10 on 8th Generation Intel Core vPro Processors Offer up to 1.53x Faster Performance over Systems Running Windows 10 on 6th Generation Intel Core vPro Processors in Transcoding Professional Videos"

For this test, the following action was timed on systems powered by 6th 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: September 2019

UP TO 1.53x BETTER PERFORMANCE TRANSCODING PROFESSIONAL VIDEOS		
Lenovo		
Device	Lenovo® ThinkPad® T470s	Lenovo ThinkPad T590
Processor	Intel® Core™ i7-6600U processor (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows® 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	01:25:24	01:02:53
HP		
Device	HP® EliteBook® 840 G3	HP EliteBook 830 G6
Processor	Intel Core i7-6600U processor (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	01:26:55	00:55:20
Dell		
Device	Dell™ Latitude™ E5470	Dell Latitude 7400
Processor	Intel Core i7-6600U (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	01:28:19	00:51:09
Average time (hours:minutes:seconds) for all three devices	01:26:53	00:56:27

Mathematical Basis for Claim of 1.53x Performance Improvement on 8th Generation Platform

= Avg. for Windows 10 on 6th Generation Intel Core vPro processor–based system/avg. for Windows 10 on 8th Generation Intel Core vPro processor–based system

= 1:26:53/0:56:27 = 5,213 seconds/3,387 seconds

= **1.53x performance improvement**

Appendix 3

Testing Details Supporting Claim 3: "Systems Running Windows 10 on 8th Generation Intel Core vPro Processors Offer up to 1.41x Faster Performance over Systems Running Windows 10 on 6th Generation Intel Core vPro Processors for System Boots"

The following actions were timed on systems with both 6th Generation Intel Core vPro processors and 8th Generation Intel Core vPro processors:

- Get to the logon prompt from a cold state.

Testing Steps for Claim 3

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

Testing dates: September 2019

UP TO 1.41x BETTER PERFORMANCE FOR SYSTEM START-UP TIMES		
Lenovo		
Device	Lenovo® ThinkPad® T470s	Lenovo ThinkPad T590
Processor	Intel® Core™ i7-6600U processor (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows® 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	00:00:12	00:00:11
HP		
Device	HP® EliteBook® 840 G3	HP EliteBook 830 G6
Processor	Intel Core i7-6600U processor (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	00:00:21	00:00:12
Dell		
Device	Dell™ Latitude™ E5470	Dell Latitude 7400
Processor	Intel Core i7-6600U (6th generation)	Intel Core i7-8665U processor (8th generation)
Operating system	Windows 10 Pro	Windows 10 Pro
Median time (hours:minutes:seconds) to complete testing steps after five runs	00:00:18	00:00:14
Average time (hours:minutes:seconds) for all three devices	**00:00:17**	**00:00:12**

Mathematical Basis for Claim of 1.41x Performance Improvement on 8th Generation Platform

= Total time (avg.) for Windows 10 on 6th Generation Intel Core vPro processor–based system/total time (avg.) for Windows 10 on 8th Generation Intel Core vPro processor–based system

= 00:17 seconds/00:12 seconds

= **1.41x performance improvement**

1   Software and workloads 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.

2   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.

3   The medium-sized business and associated personnel described in this paper's scenarios are fictional composites intended for informational purposes only.

4   Microsoft. "Meet the most secure Windows PC." **www.microsoft.com/en-us/windowsforbusiness/windows10-secured-core-computers**.

5   Intel. "Intel® vPro™ Platform TCO Estimator." **http://estimator.intel.com/vpro/**.

6   **Configurations based on Intel testing as of 2019:** *Old system:* Intel® Core™ i7-6600U processor PL1=15W TDP, two cores, four threads, Intel® Turbo Boost Technology enabling up to 3.9 GHz, Intel® HD Graphics 620, 14" screen with 1920x1080 resolution, 8 GB DDR4, 256 GB storage, 36 WHr battery, Windows® 10 Pro RS5 build version 1809 (1763v292), BIOS: v1.01; MCU: C2. *Newer system:* Intel Core i7-8665U processor, PL1=15W TDP, four cores, eight threads, Intel Turbo Boost Technology enabling up to 4.8 GHz, Intel® UHD Graphics 620, 2 x 4 GB DDR4-2400, 512 GB Intel® SSD 760p, Windows 10 RS5 build version 1809 (1763v1), BIOS: x177; MCU: A8. For more information regarding performance and benchmark results, visit **www.intel.com/benchmarks**.

7   Performance results are based on Intel testing as of March 21, 2019, and April 3, 2019, and may not reflect all publicly available security updates. "1.5 times faster" claim as measured by Microsoft® Power BI® data-source change workload comparing an 8th Generation Intel® Core™ i7-8665U processor against a 6th Generation Intel Core i7-6600U processor. This workload measures the time it takes to change the data source for a Power BI dashboard and update the dashboard with the new data. For more information regarding performance and benchmark results, visit **www.intel.com/benchmarks**.

8   Performance results are based on testing as of March 21, 2019, and April 3, 2019, and may not reflect all publicly available security updates. "1.3 times gain in multitasking times" claim as measured by Microsoft® Office Productivity and Multitasking Workload comparing an 8th Generation Intel® Core™ i7-8665U processor against a 6th Generation Intel Core i7-6600U processor. A 2.35 MB, 20-slide Microsoft® PowerPoint® .ppt presentation is exported as a 1920x1080 H.264 .mp4, 30 MB video presentation. While the video presentation is being created, 1) a 6.49 MB, 801-page, Microsoft® Word .docx document is converted to a 3.7 MB PDF file, and 2) a 68.4 MB, Microsoft® Excel® .xlsm worksheet is recalculated. For more information regarding performance and benchmark results, visit **www.intel.com/benchmarks**.

9   **Configurations based on Intel testing as of March 2019.** "55 percent better web performance" claim as measured by Principled Technologies® WebXPRT 3 comparing an 8th Generation Intel® Core™ i7-8665U processor against a 6th Generation Intel Core i7-6600U processor using an Intel reference platform. For more information regarding performance and benchmark results, visit **www.intel.com/benchmarks**.

10 Performance results are based on testing as of March 21, 2019, and April 3, 2019, and may not reflect all publicly available security updates. "Up to 65 percent in overall system performance" claim as measured by the SYSmark® 2018 benchmark test comparing an 8th Generation Intel® Core™ i7-8665U processor against a 6th Generation Intel Core i7-6600U processor. SYSmark 2018 is published by the BAPCo® benchmarking consortium. SYSmark tests Windows® desktop applications' performance using real-world scenarios for productivity, creativity, and responsiveness. Mainstream applications used in the scenarios include Microsoft® Office, Adobe® Creative Cloud®, and Google Chrome™. Each scenario produces individual metrics that roll up to an overall score. For more information regarding performance and benchmark results, visit **www.intel.com/benchmarks**.

11 Intel is a member of the BAPCo® consortium.