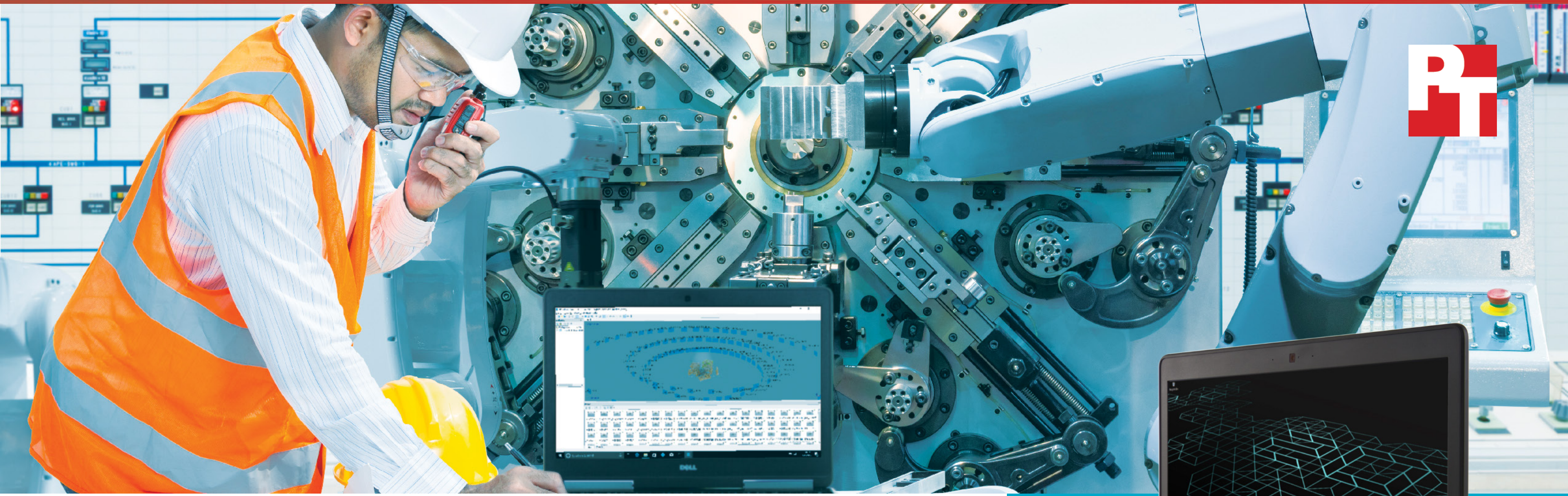


Cooler to the touch, even under a punishing workload

The Dell Precision 7520 mobile workstation kept cooler and stayed in turbo boost longer than the competition

Having a mobile workstation that doesn't overheat when you're processing a heavy workload can be a lifesaver for engineers, designers, and others working with GPU- and CPU-intensive applications.

We put three powerful mobile workstations on the market today—the Dell Precision™ 7520, Lenovo® ThinkPad® P51, and HP Zbook 15 G4—through real-world tests. We ran a demanding photogrammetry workload on each system for four and a half hours to see how these cutting-edge workhorses handled the heat.

The Dell Precision 7520 was not only comfortable to the touch at the end of the demanding photogrammetry workload, the processors maintained turbo boost longer without overheating or sacrificing performance.

Read on to see how the right mobile workstation can power productivity as well as innovation.

Stayed up to
9°C cooler
on our laps so it could work in turbo boost longer

Stayed in turbo boost up to
7% longer
so you could get more work done in less time

Why photogrammetry test results matter

Engineers and creators require powerful workstations that give them the freedom to work effectively in the field or away from their desks—no matter how demanding their projects are. Application performance can be limited by CPU speeds and the three mobile workstations we tested all employ turbo boost technology to accelerate CPU speeds when processing GPU- and CPU-intensive workloads. That's why we chose a punishing photogrammetry workload that pushed the systems to the max. In our tests, laptop configuration, workload, and environment are identical for all competitors. The only difference is platform design. While you may not utilize advanced 3D mapping or digital object reconstruction technology, results from these intensive graphics workouts will provide you with a snapshot of how well each mobile workstation manages heat under extreme duress.

Turbo boost technology

Turbo boost technology is an automated function that accelerates processor and graphics performance for peak loads. It accomplishes this by enabling the processor core to run at faster than normal frequencies whenever possible. Workload, environment, and platform design affect the amount of time processors can operate at peak calculation efficiency before they throttle down or disable turbo boost entirely to prevent overheating.

Maximize comfort

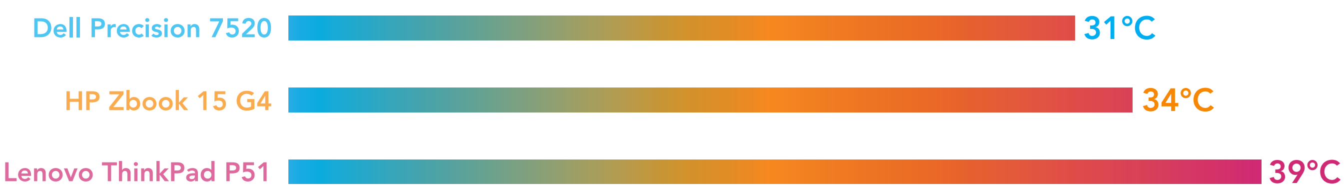
Mobile workstations are getting more powerful with each refresh and the issue of overheating is a serious concern. If not properly managed, heat can cause problems starting at physical discomfort and ending in hardware failure. In our controlled environment, none of the systems got hot enough to risk hardware failure, but the bottom of the Lenovo workstation reached 39.3°C (102.7°F) during testing, which is hot to the touch.

We ran the grueling photogrammetry workload on all of the systems for four and a half hours. All systems hit peak surface temperatures at the two-and-a-half-hour mark, with the Lenovo workstation spiking at almost ten degrees Celsius higher than when it started. By contrast, the temperature of the Dell® workstation was always cooler than the average normal human body temperature and spiked at one and a half degrees Celsius higher than its initial ambient temperature.

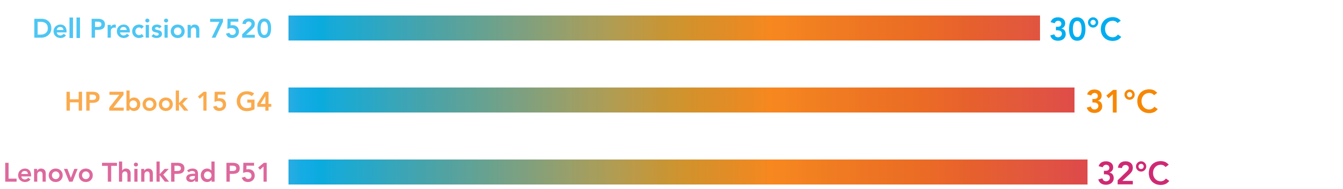
Our results show the Dell workstation stayed consistently cooler than the HP workstation and the Lenovo workstation for an extended period of time under a heavy workload.

As we stated earlier in this report, the system configuration, environment, and photogrammetry workloads were identical for all systems, so the logical conclusion from these test results is that the Dell Precision 7520 has better thermal management, which enables it to run cooler when stressed with GPU- and CPU-intensive applications like Adobe® Photoshop® or Autodesk® AutoCAD®. As we highlight in the following section, this attention to comfort and heat management does not hinder turbo boost duration or negatively affect the performance of this system.

Average bottom surface temperature



Average screen and keyboard temperature

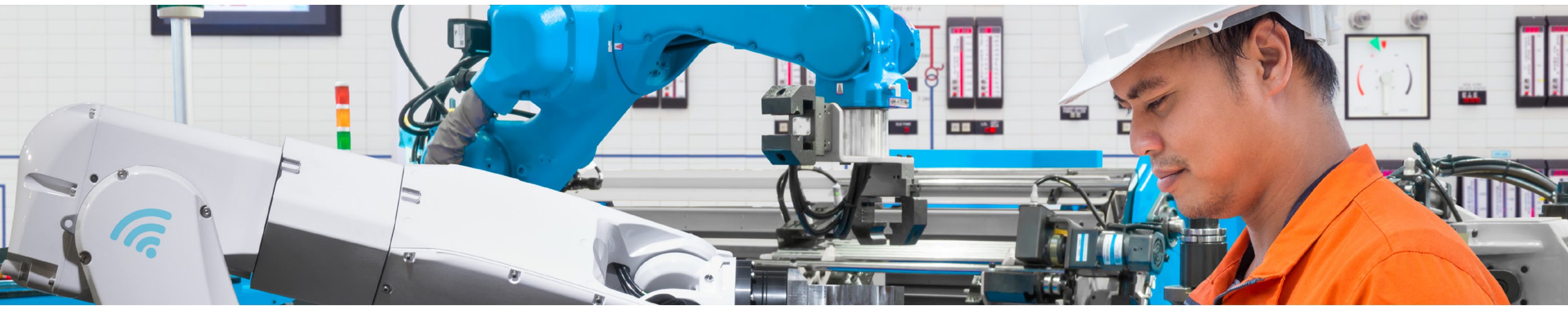


Go to Appendix B to see thermal readings on all systems during testing.

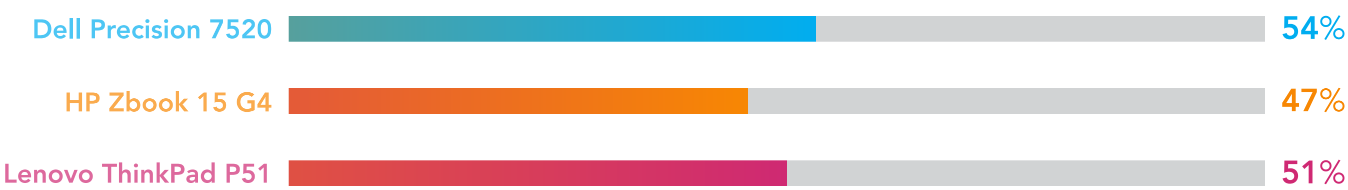
Maximize productivity

Engineers and designers need to create things as diverse as methods to transport minerals to manufacturing plants and acquiring 3D object models in the product design process. And they need a system that can handle the programs they depend on—like Autodesk AutoCAD and Adobe Photoshop—in a timely manner.

Today's mobile workstations do the work of yesterday's desktop workstations with the added benefits of mobility and turbo boost technology. Turbo boost technology accelerates processor and graphics performance for peak loads, but how long could the mobile systems in our comparison maintain these higher frequencies?



Stay in turbo boost longer so you can get more work done in less time



The Dell Precision 7520 cranked through the punishing photogrammetry workload on pace with the competition and stayed in turbo boost the longest—maintaining the higher frequency, with no noticeable rise in temperaure, for over half of the time the workload ran.

Keep pace in the race to complete a dense point cloud construction

The Dell Precision 7520 completed the task nine minutes faster than the HP Zbook 15 G4. While the Lenovo ThinkPad P51 completed the task as quickly as the Dell workstation, lap temperatures on the Lenovo workstation reached 39.3°C (102.7°F). These combined results show that the Dell Precision 7520 mobile workstation provides a balance of comfort, heat management, and performance—giving you and your team the freedom to find new ways to meet your specific goals in the best and most creative ways possible.

Seeing how well a mobile workstation handles compute-intensive photogrammetry workloads can also give you an idea about how they might handle other compute-intensive technologies such as drone mapping and GPS-powered coordination.

Conclusion

There are already enough things to worry about when you're in the field. Having a mobile workstation that can handle your demanding workloads without overheating from extended use means you can focus more on the job itself.

The Dell Precision 7520 was cooler on our laps than either the Lenovo ThinkPad P51 or the HP Zbook 15 G4. When it was time for all three mobile workstations to crunch through a punishing photgrammetry workload, the Dell Precision 7520 performed similarly to the Lenovo ThinkPad P51 and completed the task nine minutes faster than the HP Zbook 15 G4. Finally, the Dell Precision 7520 maintained turbo boost longer than either of the other mobile workstaions, which means you can get more work done in less time.

On June 21, 2017, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on July 7, 2017.

Appendix A: System configuration information

System	Dell Precision 7520	HP Zbook 15 G4	Lenovo ThinkPad P51 Signature Edition
General			
Number of processor packages	1	1	1
Number of cores per processor	4	4	2
Number of hardware threads per core	8	8	2
System power management policy	High Performance	High Performance	High Performance
System dimensions (length x width x height)	14.88” x 10.38” x 1.09-1.3”	15.2” x 10.4” x 1.0”	14.86” x 9.93” x 0.96-1.02”
System weight (lbs.)	6.16	5.73	5.6
CPU			
Vendor	Intel®	Intel	Intel
Name	Xeon® E3	Xeon E3	Xeon E3
Model number	1535M v6	1535M v6	1535M v6
Stepping	9	9	9
Socket type and number of pins	Socket 1440 FCBGA	Socket 1440 FCBGA	Socket 1440 FCBGA
Core frequency (GHz)	3.10	3.10	3.10
Bus frequency	8.0 GT/s DMI3 Link Speed	8.0 GT/s DMI3 Link Speed	8.0 GT/s DMI3 Link Speed
L1 cache	4 x 32KB + 4 x 32 - 8-way	4 x 32KB + 4 x 32 - 8-way	4 x 32KB + 4 x 32 - 8-way
L2 cache	4 x 256KB – 4-way	4 x 256KB – 4-way	4 x 256KB – 4-way
L3 cache	8MB – 16-way	8MB – 16-way	8MB – 16-way
Platform			
Vendor	Dell®	HP	Lenovo
Motherboard model number	09Y5WW	8275 / KBC Version 46.39	20HHCTO1WW
Motherboard chipset	Kaby Lake	Kaby Lake	Kaby Lake
BIOS name and version	Dell 1.1.1 (1/19/2017)	HP P70 01.01 (5/5/2017)	Lenovo N1UET34W – 1.08 (5/15/2017)

System	Dell Precision 7520	HP Zbook 15 G4	Lenovo ThinkPad P51 Signature Edition
Memory module(s)			
Vendor and model number	Hyundai HMA82GS7AFR8N-UH	Samsung® M474A2K43BB1-CRC	Samsung M474A2K43BB1-CRC
Type	DDR4-2400	DDR4-2400	DDR4-2400
Speed (MHz)	1,200	1,200	1,200
Speed running in the system (MHz)	1,200	1,200	1,200
Timing/Latency (tCL-tRCD-tRP-tRASmin)	17-17-17-39	15-15-15-35	17-17-17-39
Size (MB)	16,384	16,384	16,384
Number of memory module(s)	4	4	4
Amount of RAM in system (GB)	64	64	64
Chip organization (single-sided/double-sided)	Double-sided	Double-sided	Double-sided
Channel (single/dual)	Dual	Dual	Dual
Hard disk			
Vendor and model number	Samsung SM951	Toshiba® THNSN5512GPU7	Samsung MZVKW512HMJP-000L7
Number of disks in system	1	1	1
Size (GB)	512	512	512
RPM	N/A	N/A	N/A
Type	M.2 NVMe	M.2 NVMe	M.2 NVMe
Controller	Intel Chipset SATA RAID Controller	Standard NVM Express Controller	Standard NVM Express Controller
Driver	Intel 15.2.15.1058 (03/21/2017)	Microsoft® 10.0.15063.0 (6/21/2006)	Microsoft 10.0.15063.0 (6/21/2006)
Operating system			
Name	Windows® 10 Pro	Windows 10 Pro	Windows 10 Pro
Build number	1703	1703	1703
Service Pack	NA	NA	NA
File system	NTFS	NTFS	NTFS
Kernel	X64-based PC	X64-based PC	X64-based PC
Language	English	English	English
Microsoft DirectX® version	12	12	12

System	Dell Precision 7520	HP Zbook 15 G4	Lenovo ThinkPad P51 Signature Edition
Graphics			
Vendor and model number	NVIDIA® Quadro® M2200	NVIDIA Quadro M2200	NVIDIA Quadro M2200
Type	Discrete	Discrete	Discrete
Chipset	M2200	M2200	M2200
BIOS version	84.06.76.00.1C	84.06.7A.00.01	84.06.76.00.16
Total available graphics memory (MB)	36,778	36,787	36,767
Dedicated video memory (MB)	4,096	4,096	4,096
System video memory (MB)	0	0	0
Shared system memory (MB)	32,682	32,691	32,671
Resolution	3,840 x 2,160	3,840 x 2,160	3,840 x 2,160
Driver	NVIDIA 382.16 (Dell) (5/9/2017)	NVIDIA 382.05 (5/1/2017)	NVIDIA 382.05 (5/1/2017)
Sound card/subsystem			
Vendor and model number	Realtek Audio	Conexant ISST Audio	Realtek Audio
Driver	Microsoft 10.0.15063.0 (3/17/2017)	Microsoft 10.0.15063.447 (6/19/2017)	Microsoft 10.0.15063.447 (6/19/2017)
Ethernet			
Vendor and model number	Intel I219-LM Gigabit	Intel I219-LM Gigabit	Intel I219-LM Gigabit
Driver	Intel 12.15.23.7 (8/4/2016)	Intel 12.15.23.7 (8/4/2016)	Intel 12.15.24.1 (11/27/2016)
Wireless			
Vendor and model number	Intel Dual-Band Wireless-AC 8265	Intel Dual-Band Wireless-AC 8265	Intel Dual-Band Wireless-AC 8265
Driver	Intel 19.50.1.5 (3/15/2017)	Intel 19.40.0.3 (1/15/2017)	Intel 19.50.1.5 (3/15/2017)
USB ports			
Number	4	3	4
Type	USB 3.0	USB 3.0	USB 3.0
Other	1 x USB-C DisplayPort, HDMI, SD reader	2 x USB-C HDMI, VGA, SD reader	1 x USB-C DisplayPort, HDMI, ExpressCard, SD reader
Monitor			
LCD type	LED IPS 4K	LED IPS 4K	LED IPS 4K
Screen size	15.6"	15.6"	15.6"
Battery			
Type	Dell MFKVP Lithium-ion	HP Lithium-ion	Lenovo SB10H45078 Lithium-Ion
Rated capacity (Wh)	91	90	90

Appendix B: Detailed temperature readings

The table below shows the laptop temperature measurements, in degrees Celsius, while running the photogrammetry workload.

Laptop	Dell Precision 7520	HP ZBook 15 G4	Lenovo ThinkPad P51 Signature Edition
Workload time 0:00			
Ambient temperature	**23.1**	**23.3**	**23.1**
Average screen/keyboard temp	30.7	29.0	30.4
Hottest point screen/keyboard	47.4	44.9	55.1
Bottom surface, leg contact	30.2	28.4	29.6
Workload time 1:00			
Ambient temperature	**22.9**	**22.9**	**22.9**
Average screen/keyboard temp	31.4	34.4	33.4
Hottest point screen/keyboard	52.0	50.0	54.7
Bottom surface, leg contact	33.1	36.1	41.9
Workload time 2:00			
Ambient temperature	**22.5**	**23.0**	**22.5**
Average screen/keyboard temp	31.1	33.8	33.6
Hottest point screen/keyboard	52.4	50.1	56.1
Bottom surface, leg contact	33.1	36.3	42.5
Workload time 2:30			
Ambient temperature	**22.7**	**23.0**	**22.7**
Average screen/keyboard temp	32.1	32.4	34.0
Hottest point screen/keyboard	54.4	48.3	55.5
Bottom surface, leg contact	33.0	36.2	41.7
Workload time 3:30			
Ambient temperature	**22.6**	**22.9**	**22.6**
Average screen/keyboard temp	27.3	31.1	30.8
Hottest point screen/keyboard	45.3	44.1	54.6
Bottom surface, leg contact	29.9	32.5	36.4
Workload time 4:30			
Ambient temperature	**22.6**	**22.8**	**22.6**
Average screen/keyboard temp	29.2	29.5	31.1
Hottest point screen/keyboard	46.1	42.5	54.5
Bottom surface, leg contact	29.7	31.9	36.0

Appendix C: The scope of our testing

This appendix outlines the series of tests we used to measure surface heat that affects a user's comfort while working on the mobile workstation. To measure the thermal profile of the laptop systems as they run a performance benchmark requires two specialized tools: a FLIR® i7 thermal imaging camera with FLIR Tools and a Fluke® NetDAQ® 2680A Data Acquisition System with Type-T thermocouples, which includes a hardware device and software that runs on a controller PC.

A thermocouple is a junction between two different metals that produces a voltage related to a temperature difference. We used Type T thermocouples, which are suited for measurements in the −200° to 350°C range.

Data acquisition (DAQ) is the process of sampling signals that measure real-world physical conditions— in this case—temperature. For our testing, we installed the Fluke DAQ software on a controller PC connected via Ethernet to the NetDAQ device. Four Type T thermocouples connected to the NetDAQ device through a 20-channel input module and attached to a test point on each laptop PC under test. An extra probe measured the ambient air temperature. We placed thermocouples on the underside of each laptop in the same position where a user's right leg would touch the laptop. Each of these four channels are configured and controlled using the Fluke DAQ software installed on the controller PC. As each benchmark runs, the NetDAQ logs capture the temperature of each of the four test points. After each run, the NetDAQ log is exported to Microsoft Excel®.

In addition to logging the bottom surface temperature in real time with the NetDAQ device, we captured a thermal image of the laptops' screen and keyboard using a Fluke FLIR i7 thermal imaging camera at key points in the test run. Users operate the FLIR camera as they would a consumer-grade digital camera. The FLIR camera created a visual representation of heat variations found on each laptop. We allowed the systems to idle for a minimum of 15 minutes, and then took thermal images at the beginning of the run. Once we started testing, we took images at the one- and two-hour marks, and then at two-and-a-half hours, which is the approximate time that the workload switched from a combined CPU-and-GPU workload to a CPU-only workload. We took one more image at the three-and-a-half and four-and-a-half hour marks to document the change in heat patterns as the workload shifted. After we finished testing, we processed the images with FLIR Tools and level-set the thresholds for the images. We captured the average screen and keyboard surface temperature of each laptop, as well as the peak hot spot temperature underneath. These images and Type T Thermocouple results provide a digital thermal map of the two places that affect user comfort the most— the screen and keyboard area and the bottom of the laptop.

We reviewed the output from the NetDAQ device. Then, we correlated the data from the NetDAQ device with the data from the FLIR i7 device and the performance scores. This analysis showed how much the surface temperature rose above ambient temperature when the laptops ran the Agisoft PhotoScan workload.

Agisoft PhotoScan

Agisoft PhotoScan v1.3.1 is a photogrammetry application that converts numerous images into 3D models for use and analysis in other software. The software is used in fields ranging from film and video game development to surveying and architectural design. For more information, see http://agisoft.com.

Preparing a mobile workstation for testing

1. Using the Power Options control panel, set the power plan to high performance.
2. Set the display brightness to 100 percent:
    a. Click Start.
    b. In the Start menu's quick search field, type `Power Options`.
    c. Move the screen brightness slider all the way to the right.
3. Set the remaining power plan settings to the following:
    - Dim the display: Never
    - Turn off the display: Never
    - Put the computer to sleep: Never
4. Disable the screen saver.
5. Plug the AC adapter into the laptop, and completely charge the battery.
6. Place the laptop in a climate-controlled room.
7. Attach a type-T thermocouple to bottom of each laptop where a user's leg would touch the laptop.
8. Configure the Fluke NetDAQ 2680A Data Acquisition System to take measurements from the three surface temperature probes and one ambient temperature probe using the Fluke DAQ software.
    a. Connect the four type-T thermocouples to four channels in the Fluke Fast Analog Input module (FAI).
    b. In the Fluke DAQ software, click each surface temperature channel, select Thermocouple from the list of Functions, and choose T from the list of ranges.
    c. Label each channel with the laptop associated with each thermocouple.
    d. In the Fluke DAQ software, click the ambient temperature channel, select Thermocouple from the list of Functions, and choose T from the list of ranges.
    e. Label this channel `Ambient`.

Measuring surface temperatures of the mobile workstation running Agisoft PhotoScan

Test requirements

- Fluke 2680A Data Acquisition System
- FLIR i7 thermal camera

Setting up the test

1. Download and install Agisoft PhotoScan v. 1.3.1.
2. Copy the test workload project file and TIFFs to a local directory.

Running the test

1. Reboot the system, and allow to idle for a minimum of 15 minutes.
2. Start the Fluke 2680A data logger using the Fluke DAQ software.
3. Open the project file.
4. Choose Build Dense Point Cloud.
5. Set the Quality to Ultra high.
6. Leave the Depth Filtering set to Aggressive, and Reuse depth maps set to No.
7. Click OK.
8. Record the temperature using the FLIR i7 at launch, at the one- and two-hour marks, and at two-and-a-half, three-and-a-half, and four-and-a-half-hour marks.
9. When all workloads complete, stop the Fluke 2680A data logger using the Fluke DAQ software.
10. Save the thermal measurement data to a CSV file.
11. Complete steps 2 through 10 two more times, and report the median of the three runs.
12. Use the thermal measurement CSV file to find and report the highest temperature measured at each location during the test.
13. Match the FLIR images to the median run for each laptop, and use FLIR Tools to properly level-set the data across all three laptops.

This project was commissioned by Dell Technologies.