WORKSTATION HEAT AND POWER USAGE: LENOVO THINKSTATION P700 VS. DELL PRECISION T7810 WORKSTATION

Run cooler. Use less energy.

The Lenovo® ThinkStation® P700

up to **51.2%** cooler

up to **4.6%** less energy

vs. the Dell™ Precision™ T7810

Workstations vary considerably in the amount of heat they generate and in the amount of power they consume. A system with a cooler operating temperature helps you in two ways: its components are less likely to fail, and it necessitates less air conditioning to keep the office at a comfortable temperature. A more power-efficient system can lower your electric bill by using less electricity and running cooler.

At Principled Technologies, we tested the Lenovo ThinkStation P700 and the Dell Precision T7810 Workstation. We found that the Lenovo workstation was less power-hungry than the Dell workstation while idle and was cooler while idle and under load. These findings show that the Lenovo ThinkStation P700 could contribute to a reliable user experience and a more comfortable office environment while saving on electricity costs.

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A PRINCIPLED TECHNOLOGIES REPORT

Commissioned by Lenovo

WHICH WORKSTATION DELIVERS RELIABILITY, POWER-EFFICIENCY, AND A PLEASANT WORK ENVIRONMENT?

A workstation that generates more heat and uses more power than necessary can be more prone to system failure, can be distracting and uncomfortable for workers, and can boost electricity bills—both because of the power the system itself draws and the power that additional air conditioning uses. To determine how two workstations compared on these fronts, we measured the heat and power consumption of the Lenovo ThinkStation P700 and the Dell Precision T7810 Workstation.

We performed the tests while the two systems were idle and again while they were running a heavy workload that consisted of two benchmarks stressing each system's hard disk, processor, and memory.

Figure 1 presents highlights of our test results.

	Lenovo ThinkStation P700	Dell Precision T7810	Lenovo ThinkStation P700 was…
Heat (degrees Celsius above room temperature)			
Idle			
Average rear system exhaust fan	4.61°	10.19°	54.8% cooler
Average of six surface locations	2.0°	4.1°	51.2% cooler
Under load			
Average rear system exhaust fan	21.45°	25.55°	16.0% cooler
Average of six surface locations	6.2°	8.7°	28.7% cooler
Power usage (watts)			
Average while idle	72.0	75.5	Used 4.6% less power
Average under load	281.7	276.5	

Figure 1: Test results summary. Lower numbers are better.

For detailed specifications of our test systems, see Appendix A. For details of our testing, see Appendix B.

COOL UNDER PRESSURE

The operating temperatures of computers vary considerably. While one advantage of a cooler workstation is obvious—no one wants a hot office—workstations running at cooler temperatures also bring other benefits.

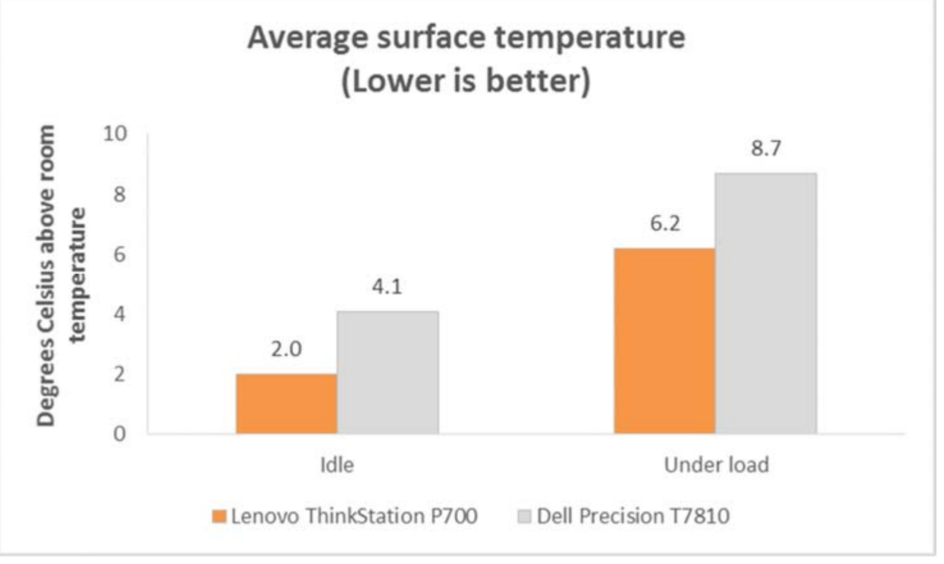
Excess heat can cause hard drives, CPUs, memory, and other components to fail. For example, overheating can expand hard drive platters, causing hard drive failure. At the very least, excess heat can reduce the drive's effective operating life. According to a recent Fujitsu white paper, hard disk manufacturers now suggest cooler operating temperatures for drive enclosures.[1] Because many users fail to back up their data on a regular basis, adequate ventilation and cooling in a workstation can help significantly to avoid problems such as catastrophic data loss due to hard drive failure.

Many workers are not fortunate enough to have control over the climate in their offices. Not only do workstations with higher operating temperatures place extra wear on hardware, but they can make an already warm office even more uncomfortable.

With system reliability and user comfort in mind, we measured the temperature of several external spots on the two workstations while they were idle and while they were running a heavy workload. Given that most workstations run 24 hours a day, we believe the most appropriate measure of thermal performance is the temperature of the air exiting the rear exhaust when the workstation is idle.

For each of the locations, we measured the temperature three times and noted the number of degrees Celsius each measurement deviated from the ambient room temperature. Because the ambient temperature varied throughout our testing, the temperature difference between the ambient temperature and the surface temperature we recorded for each system makes the fairest comparison. As Figure 2 shows, the Lenovo ThinkStation P700 ran cooler idle and while under load.

Figure 2: When idle and under load, the Lenovo ThinkStation P700 ran cooler than the Dell workstation.



LESS POWER USED IS BETTER

A workstation that uses less power can save you money when the electric bill comes. As Figure 3 shows, when the two systems were idle, the Lenovo ThinkStation

[1] www.fujitsu.com/downloads/COMP/fcpa/hdd/sata-mobile-ext-duty_wp.pdf

P700 used 4.6 percent less power than the Dell workstation. We used an Extech® Power Analyzer to measure power consumption.

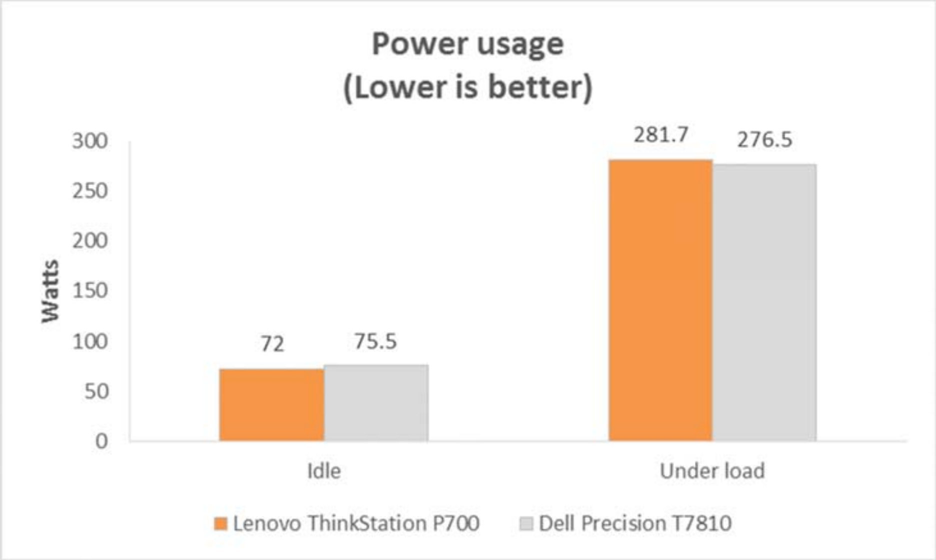


Figure 3: When idle, the Lenovo ThinkStation P700 used up to 4.6 percent less power than the Dell workstation.

IN CONCLUSION

A workstation that runs coolly and uses less power is a great asset to workers and the companies they work for. In our tests, the Lenovo ThinkStation P700 ran at lower surface temperatures while idle and under load and used less power than the Dell Precision T7810 Workstation while idle. These findings show that the Lenovo ThinkStation P700 could meet the needs of those who want to provide a reliable, comfortable work environment while using less power.

APPENDIX A: DETAILED SYSTEM CONFIGURATION

Figure 4 presents detailed configuration information for the two systems we tested.

System	Lenovo ThinkStation P700	Dell Precision Tower 7810
General		
Number of processor packages	2	2
Number of cores per processor	10	10
Number of hardware threads per core	2	2
Total number of processor threads in system	40	40
System power management policy	ThinkCentre® Default	Dell
Processor power-saving option	Enhanced Intel® SpeedStep® Technology	Enhanced Intel SpeedStep Technology
CPU		
Vendor	Intel	Intel
Name	Xeon®	Xeon
Model number	E5-2650V3	E5-2650V3
Stepping	M0	M0
Socket type	Socket 2011 LGA	Socket 2011 LGA
Core frequency (GHz)	2.3 GHz – 3.0 GHz (Turbo)	2.3 GHz – 3.0 GHz (Turbo)
L1 cache	10 × 32 KB + 10 × 32 KB	10 × 32 KB + 10 × 32 KB
L2 cache	10 × 256 KB	10 × 256 KB
L3 cache	25 MB	25 MB
Platform		
Vendor	Lenovo	Dell
Motherboard model number	N/A	0GWHMW
Motherboard chipset	Intel C600	Intel C610
BIOS name and version	Lenovo A5KT73AUS (06/04/2015)	Dell A07 (04/14/2015)
Memory module(s)		
Vendor and model number	Hyundai Electronics HMA41GR7MFR4N-TF	Hyundai Electronics HMA41GR7MFR8N-TF
Type	DDR4-2133	DDR4-2133
Speed (MHz)	2,133	2,133
Speed running in the system (MHz)	2,133	2,133
Timing/Latency (CL-tRCD-tRP-tRAS-tRFC)	31-31-31-63-1023	31-31-31-63-1023
Size (MB)	8,192	8,192
Number of memory module(s)	8	8
Total amount of system RAM (GB)	64	64
Channel (Single/Dual/Quad)	Quad	Quad
Hard disk		
Vendor and model number	Western Digital WD5000AAKX-0	Seagate ST500DM002-1BD14

System	Lenovo ThinkStation P700	Dell Precision Tower 7810
Number of disks in system	2	2
Size (GB)	500	500
Buffer size (MB)	16	16
RPM	7,200	7,200
Type	SATA 6.0 Gb/s	SATA 6.0 Gb/s
Controller	Intel C600+/C220+ series chipset SATA RAID Controller	Intel C600+/C220+ series chipset SATA RAID Controller
Driver	Intel 4.2.0.1136 (02/12/2015)	Intel 4.2.0.1136 (02/12/2015)
Operating system		
Name	Windows® 7 Professional	Windows 7 Professional
Build number	7601	7601
Service Pack	1	1
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Microsoft DirectX version	11	11
Graphics		
Vendor and model number	NVIDIA® Quadro® K620	NVIDIA Quadro K620
Type	Discrete	Discrete
Chipset	Quadro K620	Quadro K620
BIOS version	82.7.7a.0.3	82.7.5a.0.15
Total available graphics memory (MB)	5,839	5,850
Dedicated video memory (MB)	2,048	2,048
System video memory (MB)	0	0
Shared system memory (MB)	3,791	3,802
Resolution	1280 × 1024	1280 × 1024
Driver	NVIDIA 9.18.13.4803 (04/13/2015)	NVIDIA 9.18.13.4066 (08/04/2014)
Sound card/subsystem		
Vendor and model number	Realtek High Definition Audio	Realtek High Definition Audio
Driver	Realtek 6.0.1.7240 (05/06/2014)	Realtek 6.0.1.6068 (04/07/2015)
Ethernet		
Vendor and model number	Intel Ethernet Connection (2) I218-LM	Intel Ethernet Connection I217-LM
Driver	Intel 12.12.80.19 (09/29/2014)	Intel 12.12.80.19 (09/29/2014)
Optical drive(s)		
Vendor and model number	LG GHC0N	LG DTA0N
Type	DVD-RW	DVD-ROM
USB ports		
Number	12	10
Type	8 × USB 3.0, 4 × USB 2.0	4 × USB 3.0, 6 × USB 2.0
Other	Media Card Reader	Media Card Reader

System	Lenovo ThinkStation P700	Dell Precision Tower 7810
Monitor		
Model	ViewSonic VG730m	ViewSonic VG730m
LCD type	SXGA LCD	SXGA LCD
Screen size	17″	17″
Refresh rate	60 Hz	60 Hz
Maximum Resolution	1,280 × 1,024	1,280 × 1,024

Figure 4: Detailed configuration information for the test systems.

APPENDIX B: DETAILED TEST METHODOLOGY

Measuring surface temperature

Test requirements

- Fluke® 2680A Data Acquisition System
- PassMark® BurnInTest™ Professional
- LINPACK benchmark

Measuring system temperature and power while idle

Setting up the test

1. Set the power plan to the manufacturer's default setting. 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.
2. Set the remaining power plan settings as follows:
   - Dim the display: Never
   - Turn off the display: Never
   - Put the computer to sleep: Never
3. Disable the screen saver.
4. Place the workstation, mouse, keyboard, and display in a windowless, climate-controlled room.
5. Attach a Type T thermocouple to the exterior of the workstation at the following locations:
   - Front (Centered in front of Intake fan if there is one, otherwise centered of case)
   - Rear Exhaust fan (Centered)
   - PSU Exhaust fan (Centered)
   - Top (Centered)
   - Side closest to the motherboard (Centered)
   - Side opposite to the motherboard (Centered)
6. Configure the Fluke 2680A Data Acquisition System to take measurements from the temperature probes and one ambient temperature probe using the Fluke DAQ software:
   a. Connect the Type T thermocouples to 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 location 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.
7. While running each test, use a Fluke 2680A Data Acquisition System to monitor ambient temperature and temperature at each interior and exterior point.
8. Connect the power cord from the workstation to the Extech Instruments 380803 Power Analyzer's DC output load power outlet.
9. Plug the power cord from the Power Analyzer's DC input voltage connection into a power outlet.
10. Connect a separate host computer to the Power Analyzer using an RS-232 cable. This computer will monitor and collect the power measurement data.
11. Turn on the Extech Power Analyzer by pressing the green On/Off button.
12. Turn on the host computer.

13. Insert the Extech software installation CD into the host computer, and install the software.
14. Once installed, launch the Extech Power Analyzer software, and configure the correct COM port.

Running the test

1. Open Task Manager.
2. Bring up an elevated command prompt:
   - Select Windows Start orb.
   - Type `cmd` and press Control-Shift-Enter.
3. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
4. Do not interact with the system until the command completes.
5. Watch Task Manager and wait for disk activity to end before running the test.
6. Start the Fluke 2680A data logger using the Fluke DAQ software, and begin recording power with the Extech Power Analyzer.
7. Allow the workstation to sit idle for 1 hour.
8. After 1 hour, stop the Fluke 2680A data logger using the Fluke DAQ software, and stop the Power Analyzer data logger.
9. Export the thermal measurements to a CSV file. The Power Analyzer creates a CSV file as it collects that data.
10. Use the thermal measurement CSV file to find and report the average temperature measured at each location during the test.
11. Use the Power Analyzer CSV to calculate the average power draw in watts during the test.
12. Power the workstation off for 1 hour, and allow it to return to room temperature.
13. Repeat steps 1 through 9 two more times.

Measuring system temperature and power while under load

Setting up the test

1. Download PassMark BurnInTest Professional 7.0 from www.passmark.com/products/bit.htm.
2. Double-click bitpro_x64.exe to run setup.
3. At the Welcome screen, click Next.
4. Accept the license agreement, and click Next.
5. At the Choose Install Location screen, accept the default location of C:\Program Files\BurnInTest, and click Next.
6. At the Select Start Menu Folder screen, click Next.
7. At the Ready to Install screen, click Install.
8. At the Completing the BurnInTest Setup Wizard screen, deselect View Readme.txt, and click Finish to launch BurnInTest.
9. At the Purchasing information screen, copy and paste the Username and key, and click Continue.
10. At the Key accepted screen, click OK.
11. Select Test selection and duty cycles from the Configuration menu item.
12. Set Auto Stop to 120 minutes.
13. Select CPU, 2D Graphics, 3D Graphics, RAM, and Disk(s), and deselect all other subsystems.
14. Set load to 100 for each of the above selected subsystems, and click OK.
15. Select Test Preferences from the Configuration menu item and set or verify the following by clicking on each tab:
   - Disk: select C: drive
   - Logging: select Turn automatic logging on
   - 2D Graphics: select All available Video Memory

- 3D Graphics: use defaults
- CPU: use defaults

16. Unpack the LINPACK benchmark and adjust the number of instances, problem size, and leading dimension size so that the CPU is at 100% utilization, and the memory is as close to 100% utilization as possible. For example, for a system that has 8 threads:
    a. Open the Instance1 directory.
    b. Edit the runme_xeon64 batch file.
    c. Set the OMP_NUM_THREADS= 8 (this number depends on how many threads the system has)
    d. Delete the two echo lines, and save the batch file.
    e. Repeat steps a-e for each LINPACK Instance that needs to be run. (This is done by trial and error on each system until CPU and RAM utilization is as close to 100% as possible.)
    f. Once it is determined how many instances are needed, you are ready to start the test.

Running the test

1. Boot the system and launch PassMark BurnInTest by double-clicking the desktop icon.
2. Open Task Manager.
3. Bring up an elevated command prompt:
    a. Select Windows Start orb.
    b. Type `cmd` and press Control-Shift-Enter.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
   Do not interact with the system until the command completes.
5. Watch Task Manager and wait for disk activity to end before running the test.
6. Click Start Selected Tests in the BurnInTest V7.0 Pro screen, and double-click the LINPACK benchmark batch file.
7. Once RAM levels have reached the desired level, close to 100%, start the Fluke 2680A data logger using the Fluke DAQ software, and begin recording power with the Extech Power Analyzer.
8. After 1 hour, stop the Fluke 2680A data logger using the Fluke DAQ software, and the Power Analyzer data logger.
9. Export the thermal measurements to a CSV file. The Power Analyzer creates a CSV file as it collects that data.
10. Use the thermal measurement CSV file to find and report the highest temperature measured at each location during the test.
11. Use the Power Analyzer CSV to calculate the average power draw in watts during the test.
12. Power the workstation off for 1 hour, and allow it to return to room temperature.
13. Repeat the steps 1 through 12 two more times.

Measuring power consumption

To record each workstation's power consumption during each test, we used an Extech Instruments (www.extech.com) 380803 Power Analyzer/Datalogger. We connected the power cord from the server under test to the Power Analyzer's output load power outlet. We then plugged the power cord from the Power Analyzer's input voltage connection into a power outlet.

We used the Power Analyzer's Data Acquisition Software (version 2.11) to capture all recordings. We installed the software on a separate Intel processor-based PC, which we connected to the Power Analyzer via an RS-232 cable. We captured power consumption at one-second intervals. We then recorded the power usage (in watts) for each system during the testing at one-second intervals. To compute the average power usage, we averaged the power usage during the time the system was producing its peak performance results.

ABOUT PRINCIPLED TECHNOLOGIES

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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.