WORKSTATION HEAT, SOUND, AND POWER USAGE: LENOVO THINKSTATION C30 VS. DELL PRECISION T5600

When selecting a workstation, it’s important to consider how it will contribute to a reliable and comfortable work environment for the user and how much electricity it will require. Workstations vary considerably in the amount of heat and noise they generate and in the amount of power they consume. A system with a cooler operating temperature helps you two ways: by being less likely to fail and by requiring less air conditioning to keep the office at a comfortable temperature. A quieter system provides a more pleasant user experience and a more power-efficient system lowers your electric bill by using less electricity and running cooler, which reduces the amount of cooling required.

In our labs, Principled Technologies (PT) tested the Lenovo ThinkStation C30 and the Dell Precision T5600 workstation. We found that the Lenovo workstation was quieter and less power-hungry than the Dell workstation, and had lower surface temperatures while idle and while under load. These findings show that the Lenovo ThinkStation C30 could contribute to a reliable user experience and a comfortable office environment and save on electricity costs.

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WHICH WORKSTATION MAKES FOR A RELIABLE, PLEASANT, AND POWER-EFFICIENT WORK ENVIRONMENT?

A workstation that generates more heat and noise 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, noise, and power consumption of the Lenovo ThinkStation C30 and the Dell Precision T5600 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 C30	Dell Precision T5600	Comparison
Heat (degrees Celsius above room temperature)			
Rear system fan exhaust (idle)	3.9°	7.4°	89.7% cooler
Average of 5 internal locations (idle)	9.4°	10.8°	14.9% cooler
Acoustics (decibels)			
Idle	24.8	31.2	35.8% quieter*
Under load	27.7	38.7	53.3% quieter*
Power usage (watts)			
Idle	68.1	89.3	Used 23.7% less power
Under load	128.7	134.7	Used 4.5% less power

Figure 1: Test result summary. Lower numbers are better. *For explanation of acoustics comparison, see the Quieter is Better section below.

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.

It is well known within the IT industry that operating temperatures degrade hardware reliability. 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 goes a long way to avoiding 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 key internal and external spots on the two workstations while they were idle and while they were running a heavy workload. However, 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.

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

QUIETER IS BETTER

Any user, given a choice, would prefer a quiet system to a noisy one. As Figure 2 shows, the Lenovo ThinkStation C30 was considerably quieter than the Dell Precision T5600 under both load conditions.

We calculated the difference in perceived volume with the two workstations using the following formula[2] for sound level change:

$$\Delta L = 10 \cdot log2x = 33.22 \cdot \log(x)$$

The change in sound level (ΔL) is related to the ratio for loudness (or volume) by using the calculated ΔL as follows:

$$x = 10^{\frac{\Delta L}{33.22}} = 2^{\frac{\Delta L}{10}}$$

For example, if the level change (ΔL) is 6.4dB, the ratio for loudness is 1.558x, or 55.8 percent louder.

Using this approach, we determined that the Dell Precision T5600 was 55.8 percent louder than the Lenovo ThinkStation C30 when the systems were idle and 114.4 percent louder when they were under load.

Another way to look at this same data is that the Lenovo ThinkStation C30 was 35.8 percent quieter than the Dell Precision T5600 when both systems were idle and 53.3 percent quieter when they were both under load.

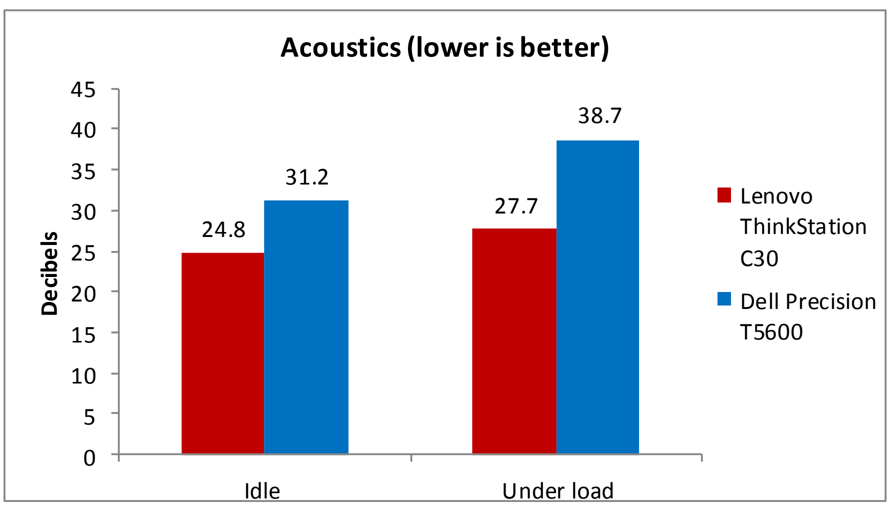

Figure 2: The Lenovo ThinkStation C30 was quieter than the Dell Precision T5600 both when idle and when under load.

[2] http://www.sengpielaudio.com/calculator-levelchange.htm

LESS POWER USED IS BETTER

A workstation that uses less power saves you money when the electric bill comes. As Figure 3 shows, the Lenovo ThinkStation C30 used less power than the Dell Precision T5600—23.7 percent less when the systems were idle and 4.5 percent less when they were under load. We used an Extech® Power Analyzer to measure power consumption while the systems were idle and under load.

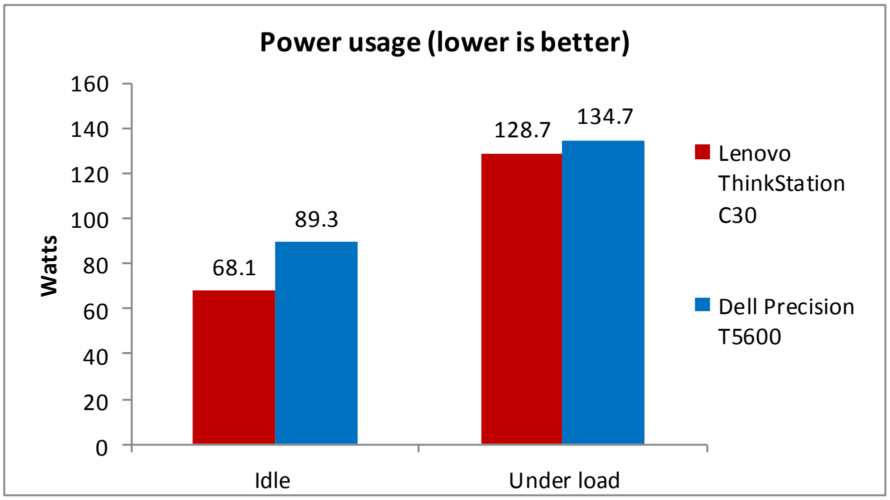

Figure 3: The Lenovo ThinkStation C30 used up to 23.7 percent less power than the Dell Precision T5600.

IN CONCLUSION

A workstation that runs in a quiet and cool manner and uses less power is a great boon to workers and the companies they work for. In our tests, both when idle and when under load, the Lenovo ThinkStation C30 ran more quietly and at lower surface temperatures than the Dell Precision T5600 workstation and used less power. These findings make the Lenovo ThinkStation C30 an excellent choice for 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 C30	Dell Precision T5600
General		
Number of processor packages	2	2
Number of cores per processor	4	4
Number of hardware threads per core	1	1
Total number of system threads	8	8
System power management policy	ThinkCentre Default	Dell
Processor power-saving option	EIST	EIST
CPU		
Vendor	Intel®	Intel
Name	Xeon®	Xeon
Model number	E5-2603	E5-2603
Stepping	M1	M1
Socket type	LGA2011	LGA2011
Bus/Core Ratio	18	18
Core frequency (GHz)	1.80	1.80
Intel QuickPath Interconnect Speed	6.4 GT/s	6.4 GT/s
L1 cache	256 KB (32 KB + 32 KB per core)	256 KB (32 KB + 32 KB per core)
L2 cache	1 MB (256 KB per core)	1 MB (256 KB per core)
L3 cache	10 MB (shared)	10 MB (shared)
Platform		
Vendor	Lenovo	Dell
Motherboard model number	Lenovo	0Y56T3
Motherboard chipset	Intel C602	Intel C602
BIOS name and version	Lenovo A1KT39AUS (08/10/2012)	Dell A04 (07/05/2012)
Memory module(s)		
Vendor and model number	Micron® MT9JSF25672PZ-1G6M1FE	Samsung® M393B5773DH0-CK0
Type	PC3-12800	PC3-12800
Speed (MHz)	1600	1600
Speed running in the system (MHz)	1600	1600
Timing/Latency (tCL-tRCD-tRP-tRASmin)	7-7-7-19	7-7-7-19
Size (MB)	2048	2048
Number of memory module(s)	4	4

System	Lenovo ThinkStation C30	Dell Precision T5600
Total amount of system RAM (GB)	8	8
Chip organization (single-sided/double-sided)	Double-sided	Double-sided
Channel (single/dual/quad)	Quad	Quad
Hard disk		
Vendor and model number	Seagate® ST500DM002-1BD14	Seagate ST500DM002-1BD14
Number of disks in system	1	1
Size (GB)	500	500
Buffer size (MB)	16	16
RPM	7,200	7,200
Type	SATA 6.0Gb/s	SATA 6.0Gb/s
Controller	Intel C600 Series Chipset SATA RAID Controller	Intel C600/X79 series Chipset 6-Port SATA AHCI Controller
Driver	Intel 3.2.0.1126 (06/20/2012)	Intel 9.2.3.1013 (03/16/2011)
Operating system		
Name	Microsoft® Windows® 7 Professional x64	Microsoft Windows 7 Professional x64
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® 600	NVIDIA Quadro 600
Type	Discrete	Discrete
Chipset	Quadro 600	Quadro 600
BIOS version	70.8.7c.0.1	70.8.88.0.1
Total available graphics memory (MB)	4,839	4,826
Dedicated video memory (MB)	1,024	1,024
System video memory (MB)	0	0
Shared system memory (MB)	3,815	3,802
Resolution	1,280 x 1,024	1,280 x 1,024
Driver	NVIDIA 8.17.12.7642 (12/10/2011)	NVIDIA 8.17.12.7619 (10/06/2011)
Sound card/subsystem		
Vendor and model number	Realtek™ High Definition Audio	Realtek High Definition Audio
Driver	Realtek 6.0.1.6581 (02/29/2012)	Realtek 6.0.1.5890 (09/23/2011)

System	Lenovo ThinkStation C30	Dell Precision T5600
Ethernet #1		
Vendor and model number	Intel 82579LM Gigabit	Intel 82579LM Gigabit
Driver	Intel 11.15.16.0 (01/11/2012)	Intel 11.15.12.0 (11/30/2011)
Ethernet #2		
Vendor and model number	N/A	N/A
Driver	N/A	N/A
Optical drive(s)		
Vendor and model number	LG DH40N	TSSTcorp SN-208BB
Type	DVD-ROM	DVD-RW
USB ports		
Number	12	10
Type	10 x USB 2.0, 2 x USB 3.0	8 x USB 2.0, 2 x USB 3.0
Other	Serial port	Serial
IEEE 1394 ports		
Number	0	0
Monitor		
Type	ViewSonic VG730m	ViewSonic VG730m
Screen size (inches)	17	17
Refresh rate (Hz)	60	60

Figure 4: System configuration information.

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 center
   - Top
   - Side opposite the motherboard
   - Side closest to the motherboard
   - Back in center of power supply exhaust
6. Attach a Type T thermocouple to the following locations inside the case:
   - On the hard drive
   - On the CPU heatsink
   - On the VRM FET
   - On the chipset heatsink
   - On one DIMM
7. Close the case.
8. 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.
9. While running each test, use a Fluke 2680A Data Acquisition System to monitor ambient and temperature at each interior and exterior point.

10. Connect the power cord from the workstation to the Extech Instruments 380803 Power Analyzer's DC output load power outlet.
11. Plug the power cord from the Power Analyzer's DC input voltage connection into a power outlet.
12. Connect a separate host computer to the Power Analyzer using an RS-232 cable. This computer will monitor and collect the power measurement data.
13. Turn on the Extech Power Analyzer by pressing the green On/Off button.
14. Turn on the host computer.
15. Insert the Extech software installation CD into the host computer, and install the software.
16. Once installed, launch the Extech Power Analyzer software, and configure the correct COM port.

Running the test

1. Boot the system and bring up an elevated command prompt:
   - Select Windows Start orb.
   - Type `cmd` and press Control-Shift-Enter.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
   Do not interact with the system until the command completes.
3. After the command completes, wait 15 minutes before running the test.
4. Start the Fluke 2680A data logger using the Fluke DAQ software, and begin recording power with the Extech Power Analyzer.
5. Allow the workstation to sit idle for 1 hour.
6. After 1 hour, stop the Fluke 2680A data logger using the Fluke DAQ software, and the Power Analyzer data logger.
7. Export the thermal measurements to a CSV file. The Power Analyzer creates a CSV file as it collects that data.
8. Use the thermal measurement CSV file to find and report the highest temperature measured at each location during the test.
9. Use the Power Analyzer CSV to calculate the average power draw in watts during the test.
10. Power the workstation off for 1 hour, and allow it to return to room temperature.
11. 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 http://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. Select CPU, 2D Graphics, 3D Graphics, and Disk(s), and deselect all other subsystems.

13. Set load to 100, and click OK.
14. 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
15. 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. We used a batch file to run the number of instances we determined for each workstation.

Running the test

1. Boot the system and launch PassMark BurnInTest by double-clicking the desktop icon.
2. Bring up an elevated command prompt:
    a. Select Windows Start orb.
    b. Type `cmd` and press Control-Shift-Enter.
3. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
   Do not interact with the system until the command completes.
4. After the command completes, wait 15 minutes before running the test.
5. Click Start Selected Tests in the BurnInTest V7.0 Pro screen, and double-click the Linpack benchmark batch file.
6. Start the Fluke 2680A data logger using the Fluke DAQ software, and begin recording power with the Extech Power Analyzer.
7. After 1 hour, stop the Fluke 2680A data logger using the Fluke DAQ software, and the Power Analyzer data logger.
8. Export the thermal measurements to a CSV file. The Power Analyzer creates a CSV file as it collects that data.
9. Use the thermal measurement CSV file to find and report the highest temperature measured at each location during the test.
10. Use the Power Analyzer CSV to calculate the average power draw in watts during the test.
11. Power the workstation off for 1 hour, and allow it to return to room temperature.
12. Repeat the steps 1 through 11 two more times.

Measuring acoustics

Test requirements

- Extech SDL600 Sound Level Meter/Datalogger with SD card
- PassMark BurnInTest Professional

Measuring acoustics of the workstation while idle

Setting up the test

1. Place the workstation, mouse, keyboard, and display in a windowless, sound-proofed professional sound booth.

2. Set the Extech SDL600 on a tripod so that it is 3 feet in front of, and 2 feet above the workstation.

Running the test

1. Boot the system and bring up an elevated command prompt:
   - Select Windows Start orb.
   - Type `cmd` and press Control-Shift-Enter.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
   Do not interact with the system until the command completes.
3. After the command completes, wait 5 minutes before running the test.
4. Start the Extech SDL600 Sound Level Meter/Datalogger and allow the workstation to sit idle for 1 hour.
5. After 1 hour, stop the Extech SDL600.
6. Power the workstation off for 10 minutes.
7. Copy the log file from the Extech SDL600 SD card.
8. Repeat steps 1 through 7 two more times.

Measuring acoustics of the workstation while under load

Setting up the test

Ensure that PassMark BurnInTest Professional 7.0 and the Linpack benchmark are set up on your system.

Running the test

1. Boot the system and launch PassMark BurnInTest by double-clicking the desktop icon.
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`
   Do not interact with the system until the command completes.
4. After the command completes, wait 15 minutes before running the test.
5. Click Start Selected Tests in the BurnInTest V7.0 Pro screen, double-click the Linpack benchmark batch file, and start the Extech SDL600 Sound Level Meter/Datalogger.
6. After 1 hour, stop the Extech SDL600.
7. Power the workstation off for 10 minutes.
8. Copy the log file from the Extech SDL600 SD card.
9. Repeat steps 1 through 8 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 1-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.