OVERVIEW

Power estimation is an important part of data center planning. Historically, data center power circuits were provisioned based on faceplate ratings—a practice that resulted in waste given that servers never consumed the legal faceplate power value. Power calculators evolved because customers demanded a more accurate, yet still safe, upper boundary for circuit provisioning. PT conducted tests to see how two server manufacturers meet this customer demand for information.

We measured maximum power for matched 1U and 2U rack-mounted server configurations from HP and Cisco, and compared those results to each vendor's online power calculator. While the actual peak power usage of comparable servers was similar, their respective calculators estimated power in drastically different ways. We found the Cisco calculator to be a conservative tool for circuit provisioning, overestimating peak power usage by 24.3 percent and 26.9 percent, whereas the HP calculator dramatically underestimated peak power by 11.5 percent and 16.9 percent.

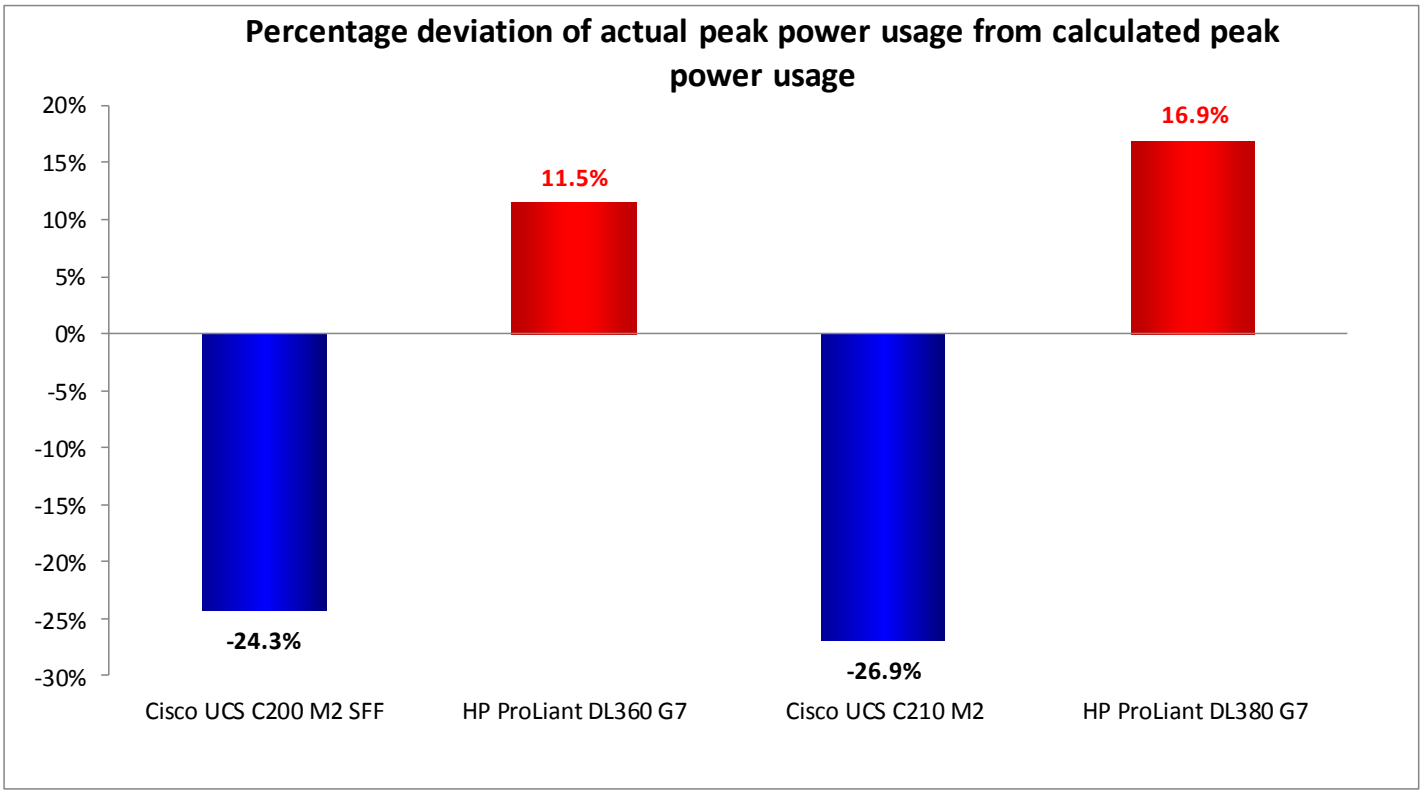

Figure 1. Percentage deviation of actual peak power usage from calculated peak power usage for the four servers we tested.

THE RISKS OF UNDERESTIMATING POWER USAGE

Underestimating power consumption poses a number of risks. If usage exceeds circuit capacity, customers run the risk of tripping a circuit breaker.

Data center managers must continually balance risk vs. cost when provisioning their data center. The faceplate ratings that were used in the past represent the maximum power supported by power supplies in the system. This is, in reality, an unattainable number. As such, customers now rely on vendors to supply safe, yet realistic, maximum power estimations through their power calculators.

Underestimating power consumption poses a number of risks. If usage exceeds circuit capacity, customers run the risk of tripping a circuit breaker and experiencing power interruptions. The consequences, such as unplanned downtime and productivity loss, can be serious. Along with power, cooling must be managed in the data center. Unexpected loads can result in hot spots and server shutdown due to overheating, which can also result in unplanned outages.

HP UNDERESTIMATES WHILE CISCO OVERESTIMATES

For the systems we tested, the HP Power Advisor underestimated peak power usage by 11.5 percent and 16.9 percent, an average of 14.2 percent.

For the systems we tested, the HP Power Advisor[1] underestimated peak power usage by 11.5 percent and 16.9 percent, an average of 14.2 percent. In contrast, the Cisco Unified Computing System (UCS) power calculator[2] overestimated peak power usage by 24.3 percent and 26.9 percent, an average of 25.6 percent.

Figure 2 shows the power usage data of the four servers.

Peak power usage in watts	Calculated peak power usage	Actual peak power usage	Percentage difference
1U servers			
Cisco UCS C200 M2 SFF	451	362.7	-24.3%
HP ProLiant DL360 G7	334	377.2	11.5%
2U servers			
Cisco UCS C210 M2	451	355.4	-26.9%
HP ProLiant DL380 G7	306	368.2	16.9%

Figure 2. Calculated peak power usage and actual peak power usage in watts for the four servers we tested.

[1] http://h18004.www1.hp.com/products/solutions/power/index.html
[2] http://www.cisco.com/assets/cdc_content_elements/flash/dataCenter/cisco_ucs_power_calculator/

Power calculators are a poor choice for comparing actual power consumption across hardware from multiple vendors.

In addition to the risks of underestimating maximum server power, the HP power calculator data incorrectly presents an apparent advantage of 100-plus watts, when in fact the actual power usage of the two Cisco UCS servers we tested was slightly lower than that of the two HP ProLiant servers. This shows that power calculators are a poor choice for comparing actual power consumption across hardware from multiple vendors.

Figure 3 charts the way that each server's actual power deviated from the vendor's estimate.

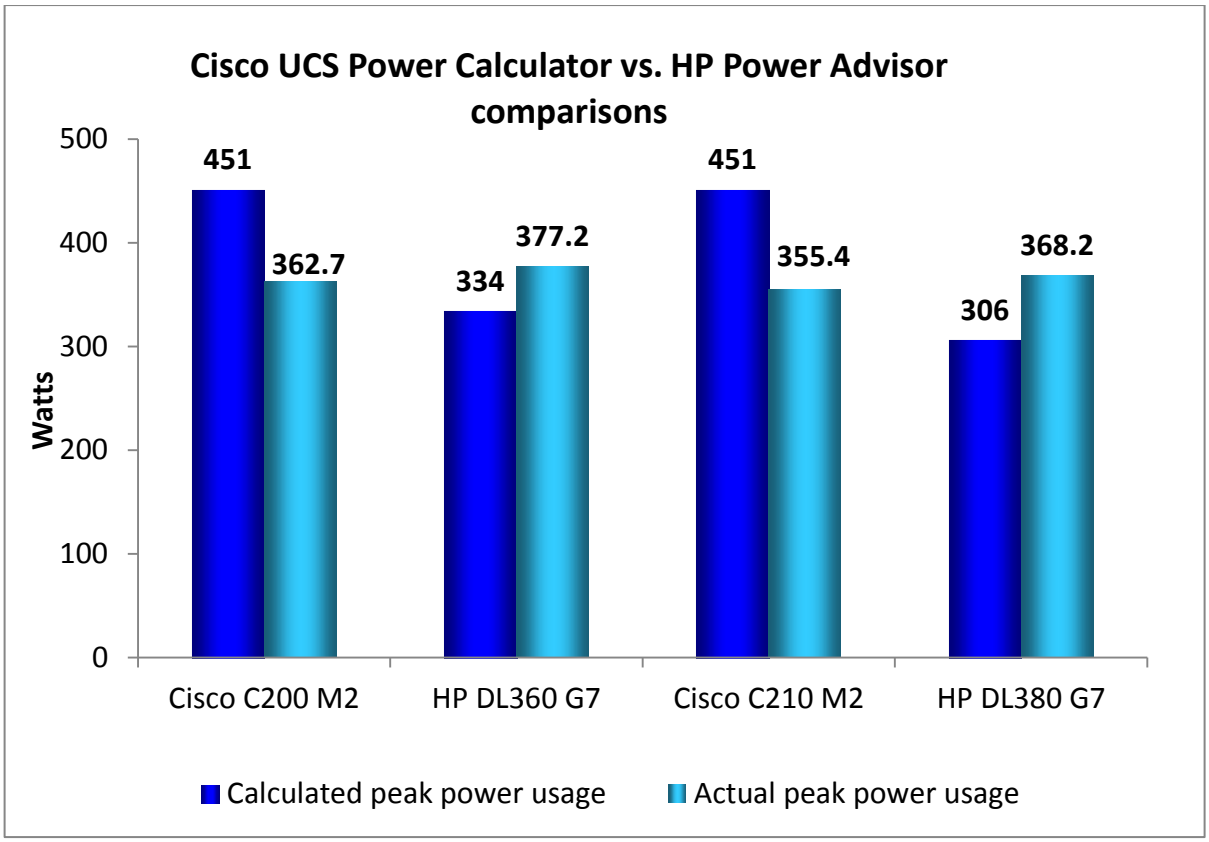

Figure 3. The two Cisco servers used an average of 25.6 percent less power than the Cisco UCS power calculator estimated, whereas the two HP servers used an average of 14.2 percent more power than the HP Power Advisor estimated.

HOW WE TESTED

We compared the calculated peak power usage and the actual peak power usage of two Cisco servers, the 1U Cisco UCS C200 M2 SFF and the 2U Cisco UCS C210 M2, and two HP servers, the 1U HP ProLiant DL360 G7 and the 2U HP ProLiant DL380 G7. We used the Cisco UCS power calculator for the Cisco servers, and the HP Power Advisor for the HP servers. We configured all servers very similarly, using the same processor model and number of processors, RAM type and amount, and so forth. (For detailed configuration information, see Appendix A.)

For the actual peak power usage data, we ran Prime95, a stability testing utility. We chose Prime95 because it is a heavily CPU-intensive application, allowing us to measure the worst-case scenario for a system's peak power consumption.

We set up the same device on each server to measure power consumption while Prime95 was running. We then used the Cisco and HP online calculators to generate maximum power usage estimates for the exact servers we tested. (We provide our detailed test methodology in Appendix B and calculator screenshots in Appendix C.)

SUMMARY

In our tests, the Cisco UCS C200 M2 SFF and UCS C210 M2 servers actually used slightly less power than the HP ProLiant DL360 G7 and ProLiant DL380 G7 servers—in contrast to the calculator data that suggests that the two HP servers use considerably less power.

This data demonstrates two things. First, that power calculators are unreliable when they are used to compare power utilization across products from different hardware vendors. Second, that, for the servers we tested, the Cisco calculator provided a more conservative estimate, one that a datacenter could rely on without risking power usage that exceeds circuit capacity.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figures 4 and 5 provide detailed configuration information about the test servers.

Servers	Cisco UCS C200 M2 SFF	HP ProLiant DL360 G7
General processor setup		
Number of processor packages	2	2
Number of cores per processor package	6	6
Number of hardware threads per core	2	2
CPU		
Vendor	Intel®	Intel
Name	Xeon® X5670	Xeon X5670
Stepping	B1	B1
Socket type	LGA 1366	LGA 1366
Core frequency (GHz)	2.93	2.93
Bus frequency	6.4 GT/s (QPI)	6.4 GT/s (QPI)
L1 cache (KB)	32 + 32 (per core)	32 + 32 (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache (MB)	12	12
Thermal design power (TDP, in watts)	95	95
Platform		
Vendor and model number	Cisco UCS C200 M2 SFF	HP ProLiant
Motherboard model number	UCSC-BSE-SFF-C200	HP ProLiant DL360 G7
Motherboard chipset	Intel 5520	Intel 5520
BIOS name and version	Cisco Systems, Inc. 1.4.1.0	HP P68
BIOS settings	Turbo boost disabled; LV DDR Mode: Performance mode	Turbo boost disabled
Memory modules		
Total RAM in system (GB)	96	96
Number of types of memory modules	1	1
Speed in the system currently running @ (MHz)	1,333	1,333
Timing/Latency (tCL-tRCD-iRP-tRASmin)	9-9-9-24	9-9-9-24
Vendor and model number	Samsung® M393B1K70CH0-YH9	HP 605313-071
Type	PC3-10600R	PC3-10600R
Speed (MHz)	1,333	1,333
Size (GB)	8	8
Number of RAM modules	12	12
Chip organization	Double-sided	Double-sided
Hard disk		
Vendor and model number	Seagate ST9300603SS	HP DG0300BALVP
Number of disks in system	1	1
Size (GB)	300	300

Servers	Cisco UCS C200 M2 SFF	HP ProLiant DL360 G7
Buffer size (MB)	16	16
RPM	10,000	10,000
Type	SAS	SAS
Controller	Cisco LSI® 1064e Controller-based mezzanine card	Smart Array P410i Controller
Power supplies		
Type	Cisco Gold	HP 460 Common Slot Platinum
Total number	2	2
Max rated wattage per supply	650	460
Cooling fans		
Total number	6	8 (4 dual-fan modules)
Dimensions (H x W) of each	1.625” x 1.625”	1.97” x 1.97”
Fan module voltage	12	12
Fan module rated amps at full speed	1.40	1.25
Operating system		
Name	Microsoft® Windows Server® 2008 R2 Enterprise Edition Service Pack 1	Microsoft Windows Server 2008 R2 Enterprise Edition Service Pack 1
Build number	7601	7601
File system	NTFS	NTFS
Language	English	English
Power option	Balanced	Balanced
Network card/subsystem		
Vendor and model number	Intel 82576 Gigabit Dual Port Network Adapter	HP NC382i Integrated Quad Port PCI Express Gigabit Server Adapter
Type	Integrated	Integrated
USB ports		
Number	2	3
Type	2.0	2.0

Figure 4. Detailed configuration information for the two 1U rack server systems.

Servers	Cisco UCS C210 M2	HP ProLiant DL380 G7
General processor setup		
Number of processor packages	2	2
Number of cores per processor package	6	6
Number of hardware threads per core	2	2
CPU		
Vendor	Intel	Intel
Name	Xeon X5670	Xeon X5670
Stepping	B1	B1
Socket type	LGA 1366	LGA 1366
Core frequency (GHz)	2.93	2.93
Bus frequency	6.4 GT/s (QPI)	6.4 GT/s (QPI)
L1 cache (KB)	32 + 32 (per core)	32 + 32 (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache (MB)	12	12
Thermal design power (TDP, in watts)	95	95
Platform		
Vendor and model number	Cisco UCS C210 M2	HP ProLiant
Motherboard model number	R210-2121605W	HP ProLiant DL380 G7
Motherboard chipset	Intel 5520	Intel 5520
BIOS name and version	Cisco Systems, Inc. 1.4.1.0	HP P67
BIOS settings	Turbo boost disabled; LV DDR Mode: Performance mode	Turbo boost disabled
Memory modules		
Total RAM in system (GB)	96	96
Number of types of memory modules	1	1
Speed in the system currently running @ (MHz)	1,333	1,333
Timing/Latency (tCL-tRCD-iRP-tRASmin)	9-9-9-24	9-9-9-24
Vendor and model number	Samsung M393B1K70CH0-YH9	HP 605313-071
Type	PC3-10600R	PC3-10600R
Speed (MHz)	1,333	1,333
Size (GB)	8	8
Number of RAM modules	12	12
Chip organization	Double-sided	Double-sided
Hard disk		
Vendor and model number	Seagate ST9300603SS	HP DG0300BALVP
Number of disks in system	1	1
Size (GB)	300	300
Buffer size (MB)	16	16
RPM	10,000	10,000
Type	SAS	SAS

Servers	Cisco UCS C210 M2	HP ProLiant DL380 G7
Controller	Cisco LSI 1064e Controller-based mezzanine card	Smart Array P410i Controller
Power supplies		
Type	Cisco Gold	HP 750 Common Slot Platinum
Total number	2	2
Max rated wattage per supply	650	750
Cooling fans		
Total number	3	6
Dimensions (H x W) of each	3” x 3”	2.60” x 2.40”
Fan module voltage	12	12
Fan module rated amps at full speed	4.90	2.45
Operating system		
Name	Windows Server 2008 R2 Enterprise Edition Service Pack 1	Microsoft Windows Server 2008 R2 Enterprise Edition Service Pack 1
Build number	7601	7601
File system	NTFS	NTFS
Language	English	English
Power option	Balanced	Balanced
Network card/subsystem		
Vendor and model number	Intel 82576 Gigabit Dual Port Network Adapter	HP NC382i Integrated Quad Port PCI Express Gigabit Server Adapter
Type	Integrated	Integrated
USB ports		
Number	2	4
Type	2.0	2.0

Figure 5. Detailed configuration information for the two 2U rack server systems.

APPENDIX B – TEST METHODOLOGY

To help us measure the power consumption of the four servers under test, we used Prime95, Mersenne prime search software created by programmer George Woltman. This application runs in the foreground, searching for a Mersenne prime number, which is almost 13 million digits long. We chose Prime95 because it is a heavily CPU-intensive application, allowing us to measure the system's power consumption under full load. According to the Prime95 stress.txt readme file, "This program is a good stress test for the CPU, memory, L1 and L2 caches, CPU cooling, and case cooling. The torture test runs continuously, comparing your computer's results to results that are known to be correct." To learn more about Prime95, visit http://www.mersenne.org/freesoft.htm.

We performed our testing at the maximum memory speed of 1,333 on both servers.

How we tested

We began our testing by installing a fresh copy of Microsoft Windows Server 2008 R2 Enterprise on each server. We followed this process for each installation:

1. Boot the server, and insert the Windows Server 2008 R2 installation DVD in the DVD-ROM drive.
2. At the Language Selection screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Click the I accept the license terms checkbox, and click Next.
6. Click Custom.
7. Click Drive options (advanced).
8. Ensure you select the proper drive, and click New.
9. Click Apply.
10. Click Next.
11. At the User's password must be changed before logging on warning screen, click OK.
12. Type `Password1` as the new password in both fields, and click the arrow to continue.
13. At the Your password has been changed screen, click OK.
14. Download the 64-bit version of Prime95, and copy it to each server's desktop.
15. Reboot the server, and allow it to sit idle for 10 minutes after you log in.
16. Launch Prime95, select the in-place large FFT torture test.
17. Run the torture test for 10 minutes, and then record the power consumption during the next 5 minutes of the test.

We used the default BIOS settings, with the exception of enabling C-states on the processors and disabling Turbo Boost. In the operating system, we set the power efficiency mode to Balanced Power. We disconnected all peripheral and network connections during the 5-minute sample period.

How we measured power

To record each server'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 recorded the power usage (in watts) for each server during the testing at one-second intervals. To compute the average power usage, we averaged the power usage during the 5-minute sample. We call this time the power measurement interval.

APPENDIX C – SCREEN SHOTS OF THE CALCULATORS

Figures 6 through 9 show the calculator screens.

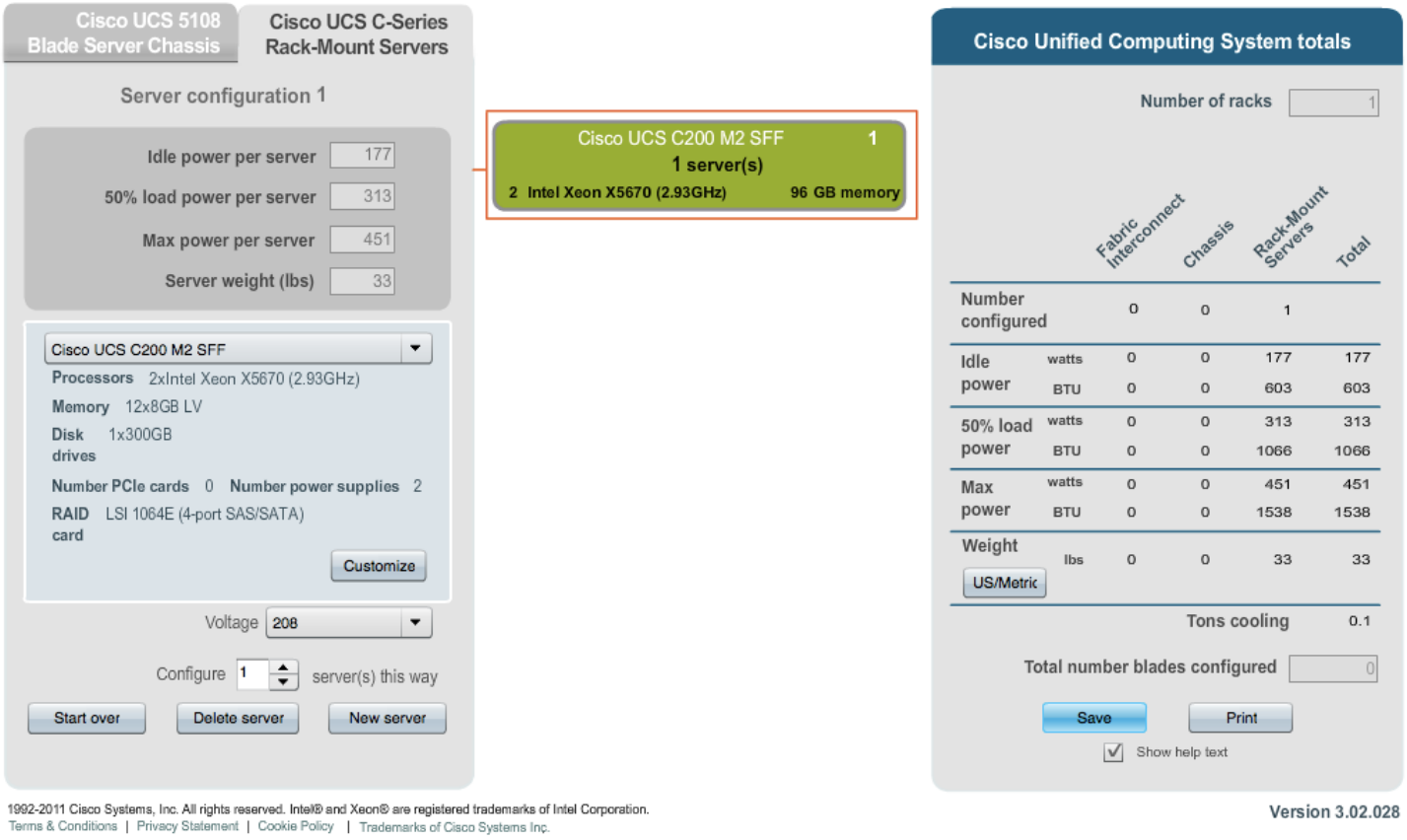

Figure 6. Screen for the Cisco UCS power calculator estimate for the Cisco UCS C200 M2 SFF server.

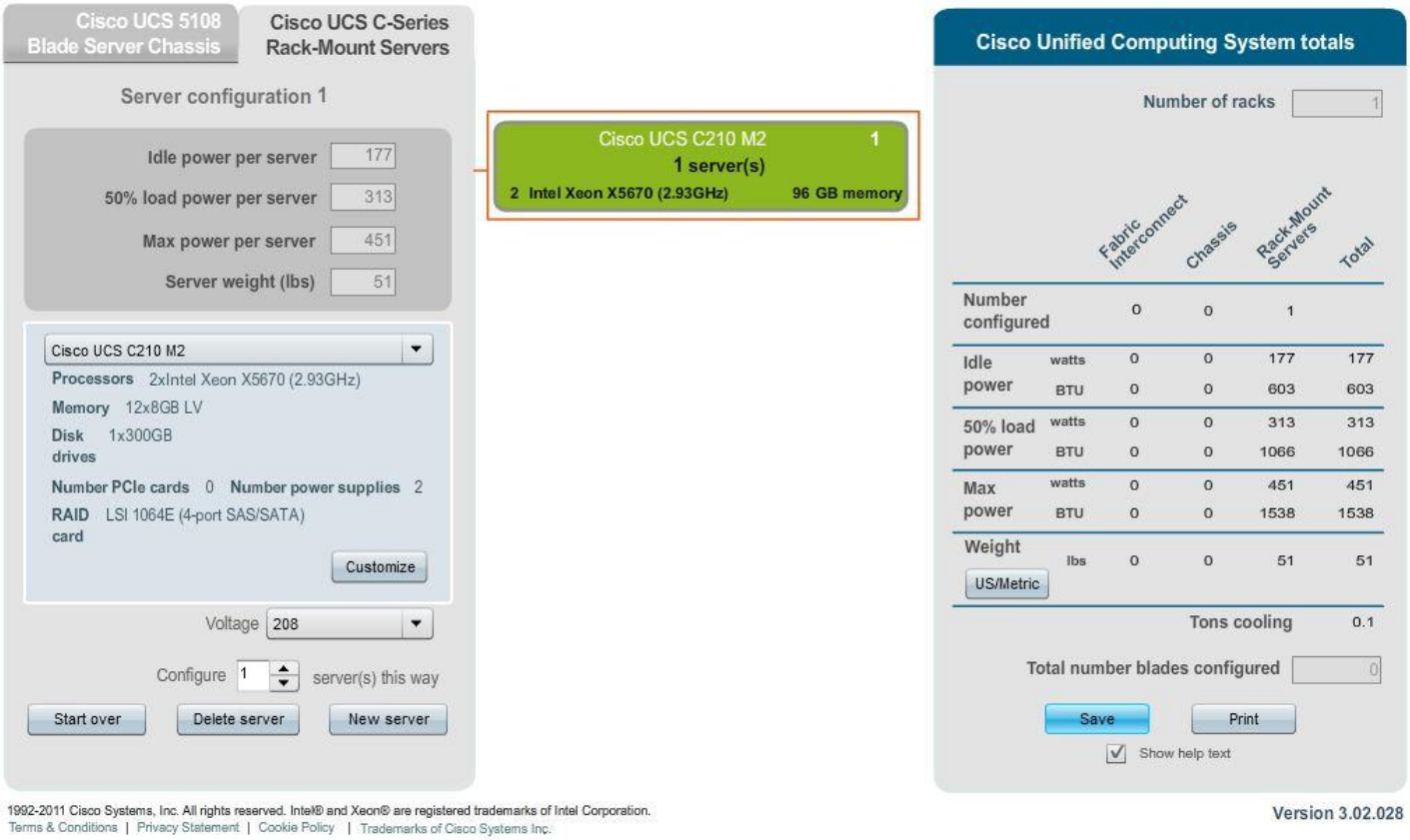

Figure 7. Screen for the Cisco UCS power calculator estimate for the Cisco UCS C210 M2 server.

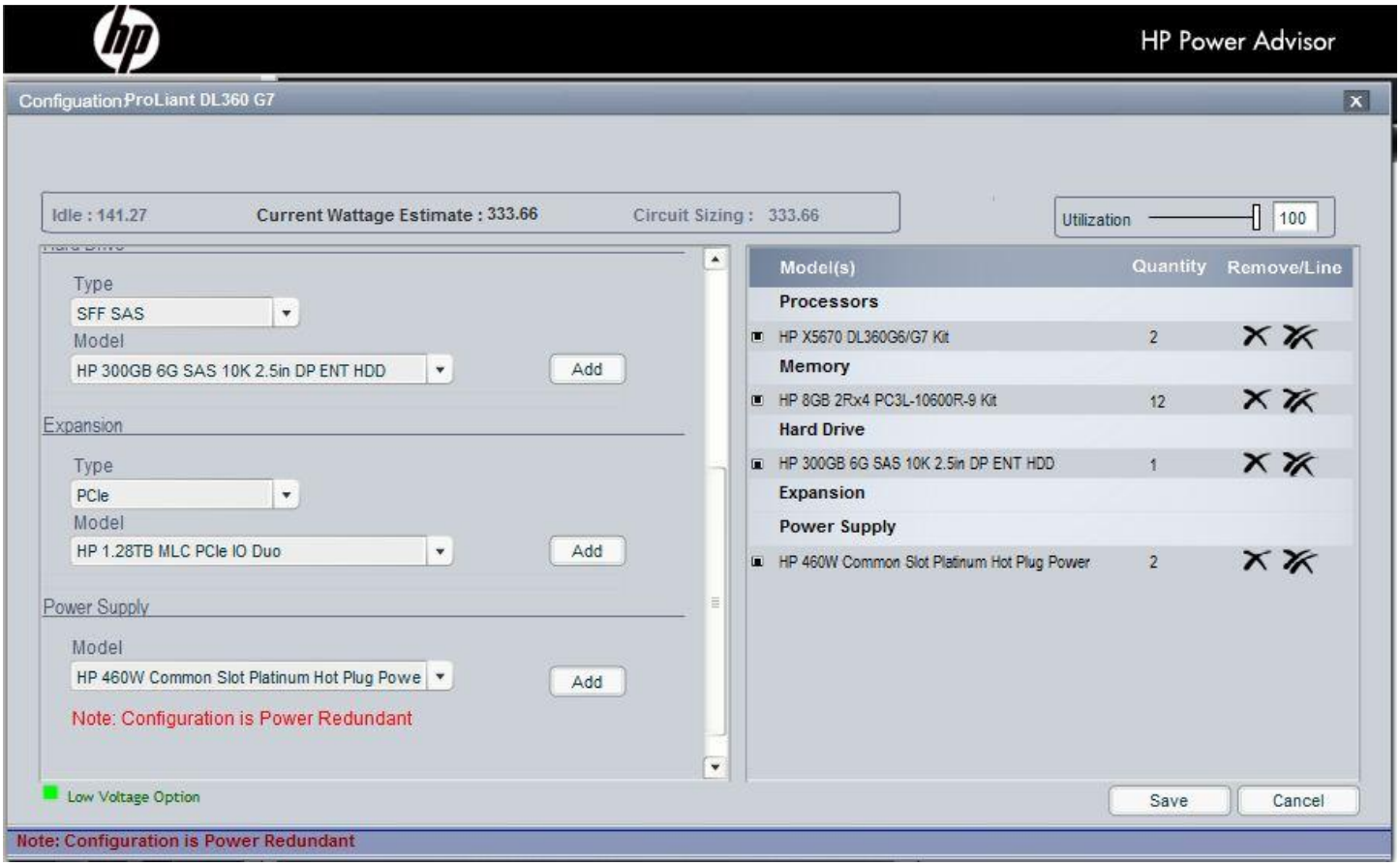

Figure 8. Screen for the HP Power Advisor estimate for the HP ProLiant DL360 G7 server.

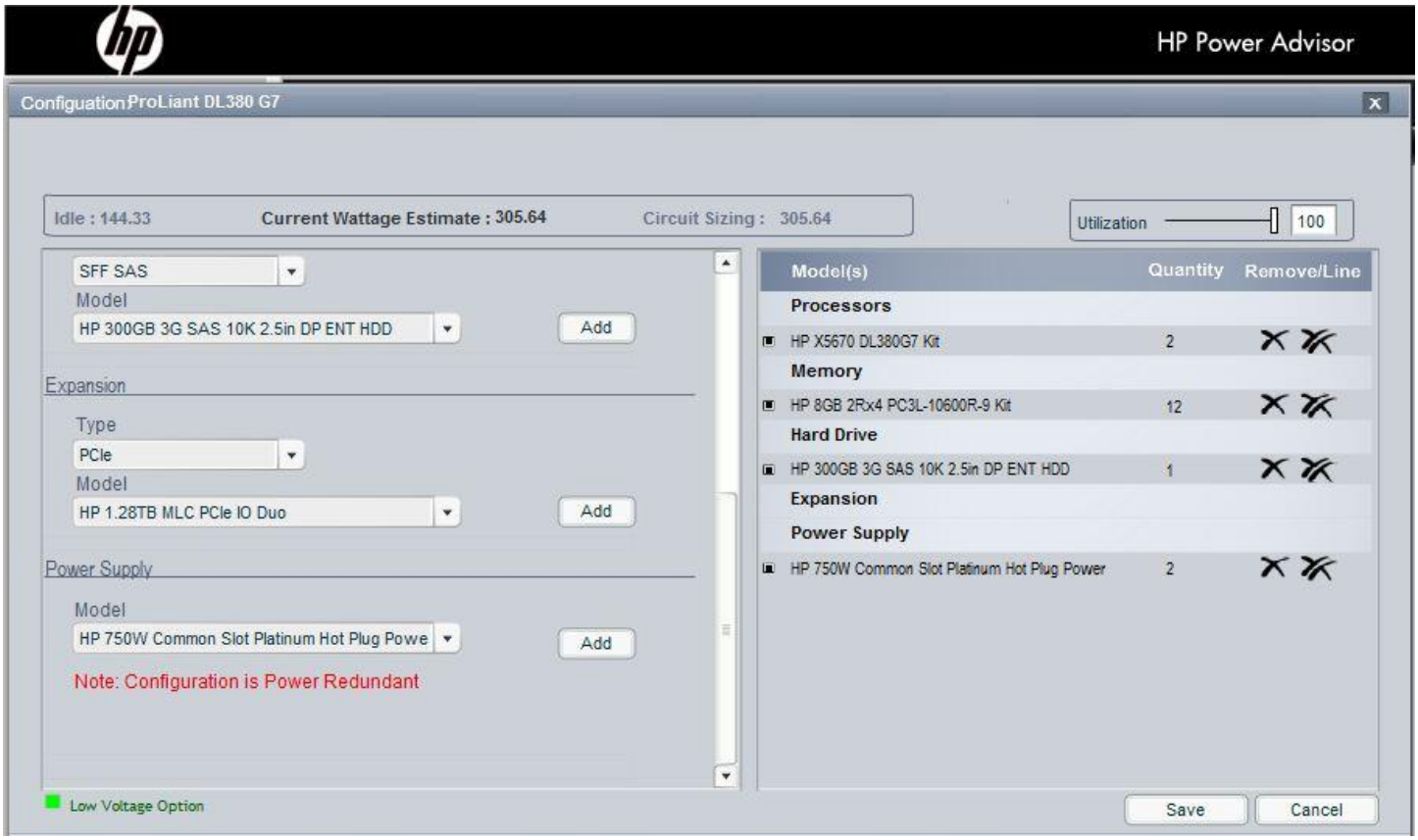

Figure 9. Screen for the HP Power Advisor estimate for the HP ProLiant DL380 G7 server.

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies, Inc.
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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.