SUN BLADE™ 6000 MODULAR SYSTEM
POWER AND COOLING EFFICIENCY

Technical Brief
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Sun Blade 6000 Modular System Power and Cooling Efficiency

In an era where most vendors build similar servers essentially out of the same parts and microprocessors from third-party vendors, the efficiency of packaging, power, and cooling becomes an increasingly important product differentiator. Where most IT organizations are struggling with the need to deploy ever more applications in the fixed space, power, and cooling envelope of their datacenters, the ability to save even a hundred Watts per system quickly turns into more breathing room for future applications and the servers to run them.

Figure 1. The Sun Blade 6000 Modular System supports up to 10 server modules in only 10 rack units.

The Sun Blade™ 6000 Modular System has been designed from the ground up to deliver far greater efficiency than the corresponding set of rack-mount servers (Figure 1). That's part of the equation that is making IT organizations everywhere consider blade systems as part of their strategy in battling the space, power, and cooling crunch. What makes IT organizations choose Sun is the additional power and cooling efficiencies they get with the Sun Blade 6000 Modular System over similar products from competitors. The Sun Blade 6000 Modular System is designed with strict front-to-back cooling, straight airflow, intelligent fan speed control, and better algorithms for maintaining sufficient airflow in compromised situations such as operating with failed fans. More efficient cooling means fewer Watts spent on the cooling subsystem, a benefit that is amplified by lower CPU power consumption resulting from lower operating temperatures.

When you purchase a blade system, it's important to know what you're getting. With Sun, you get a high-efficiency modular system that virtually doesn't limit processor choice or throttle processor clock speeds in order to operate in a lower thermal envelope. With the Sun Blade 6000 Modular System, you're already ahead with improved cooling efficiency, more powerful processors, and support for the higher memory footprint occupied by virtualized systems. With Sun you also stay ahead, as the Sun Blade 6000 Modular System's cooling system is sized for the future, capable of cooling higher-power server blades with even more demanding thermal profiles.

The Blade System Promise

For applications ranging from Web services to virtualization and high-performance computing, blade systems offer a high degree of flexibility that includes higher compute density, increased availability and serviceability, reduced complexity, faster service expansion, bulk deployment, and overall lower costs. The Sun Blade 6000 Modular System offers IT organizations with more flexibility than they have ever seen in blade systems: the ability to support server modules with AMD Opteron™, Intel® Xeon, and UltraSPARC® T1 processors with CoolThreads™ technology.

One of the key benefits that IT organizations expect of blade systems is their ability to reduce the power and cooling footprint when compared to the corresponding number of rack-unit servers — an area where the Sun Blade 6000 Modular System delivers a significant savings.

The power calculators used in these estimates are from the following locations: Sun: *http://www.sun.com/servers/blades/6000chassis/calc/index.jsp#calc*; HP: *http://h30099.www3.hp.com/configurator/powercalcs.asp*; IBM: h*ttp://www-03.ibm.com/systems/bladecenter/powerconfig/*.

Sun used its own power calculator and those from HP and IBM to obtain power consumption characteristics for the Sun Blade Modular System populated with 10 server modules vs. 10 equivalent 1U servers from HP and IBM. In each case, the servers were compared with two processors having the same power-consumption ratings, four 2 GB DIMMs per processor socket, dual power supplies running at 208 Volts, and no internal disk drives or I/O expansion cards. The comparison is equal except for the fact that the IBM servers were configured with single, not dual power supplies.

The results show that the Sun Blade 6000 Modular system can save up to 1240 Watts compared to an equivalent set of 1U servers:

- The Sun Blade 6000 Modular System configured with 10 Sun Blade X6220 Server Modules and two 95 Watt AMD Opteron Processors per module (such as dual-core 2.8 GHz 2220 series processors) saves 1240 Watts compared to 10 HP DL365 servers, and 660 Watts less than 10 single PSU-equipped IBM x3455 servers (Figure 2). The HP and IBM servers were also equipped with AMD Opteron processors having the same power consumption rating.
- The Sun Blade Modular System configured with 10 Sun Blade X6250 Server Modules populated with two 80 Watt Intel Xeon processors per module (such as dual-core 3.0 GHz Intel Xeon5160 processors) saves 1080 Watts over equivalent HP DL360 G5 servers and 960 Watts over single PSU-equipped IBM x3550 servers (Figure 3). The HP and IBM servers were also equipped with Intel Xeon processors having the same power consumption rating.

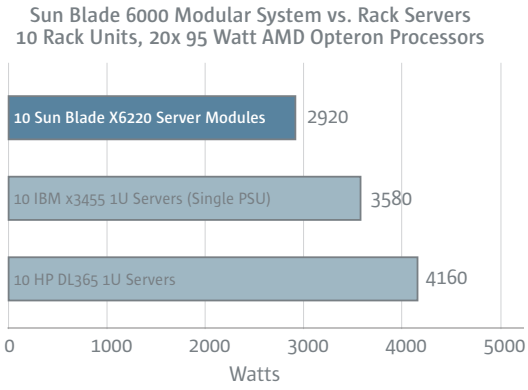

Figure 2. A Sun Blade Modular System populated with Sun Blade X6220 Server Modules saves 1240 Watts over equivalent 1U servers from HP (IBM server comparison included only a single power supply).

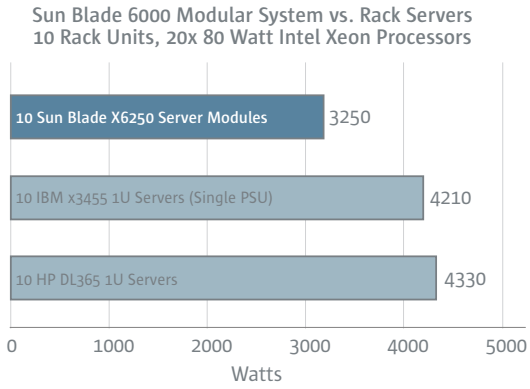

Figure 3. A similar calculation for 80 Watt Intel Xeon processors shows power savings of up to 1080 Watts using the Sun Blade 6000 Modular System.

Cooling System Overview

From the perspective of processors, memory, and supporting chips, the systems compared above have a very similar set of components. The difference in power consumption is due to the efficiencies of the Sun Blade 6000 Modular System's power and cooling subsystems. The comparison between the modular system and 1U servers is easy: the use of shared, high-capacity power supplies across all blades, and larger, more efficient cooling fans results in significant energy savings. The Sun Blade 6000 Modular System's efficiency compared to blade systems from the competition derives from the finer points of its cooling system and how it affects power consumption.

Low Airflow Resistance

The Sun Blade 6000 Modular System is designed from the ground up for low airflow resistance and optimal use of cooling air. The system has two separate airflows, one that cools the server modules, and one that cools the power supplies and I/O section (Figure 4).

The airflow across the server modules is straight through with no bends. The server modules themselves channel air over the processor heat sinks so that additional CPU cooling fans are not necessary, saving power and helping to maintain the straight-through airflow. Sun designed its memory layout so that DIMMS are spaced appropriately for cooling with low airflows, helping to reduce memory errors.

The upper air stream, which cools the power supplies, PCI-Express expansion cards, and the Network Express Modules, is also quite straight from front to back.

Figure 4. The Sun Blade 6000 Modular System uses strict, front-to-back cooling and two separate airflows.

Strict Front-To-Back Cooling

Sun designed the Sun Blade 6000 Modular System with a strict, front-to-back airflow for optimal cooling in datacenter environments that alternate “hot” and “cold” aisles. The airflow is straight through, with no recirculation, and minimal turbulence.

Compare the Sun Blade 6000 Modular System’s airflow to that of the HP BladeSystem c7000. The Sun Blade 6000 Modular System supports strict, front-to-back cooling (Figure 5), while the HP BladeSystem uses separate ducts and reverse airflow to cool its I/O and interconnect mechanisms, potentially leading to increased turbulence (Figure 6). HP’s documentation doesn’t reveal the reality that exhaust air is drawn back into the system through its I/O and interconnect mechanism, adding to inefficiency.

Cooling Fans

Sun chose to use fans, rather than blowers, because of the lower power, higher efficiency, and straight-through airflow they support. Compare the straight-through airflow of a fan to the right angle turn required for air to flow through a blower.

The Sun Blade 6000 Modular System’s cooling fans are hot-swap, N+1 redundant for both the power supply airflow and the main server module airflow. Under normal operation, fans operate at low speed, where efficiency is greatest.

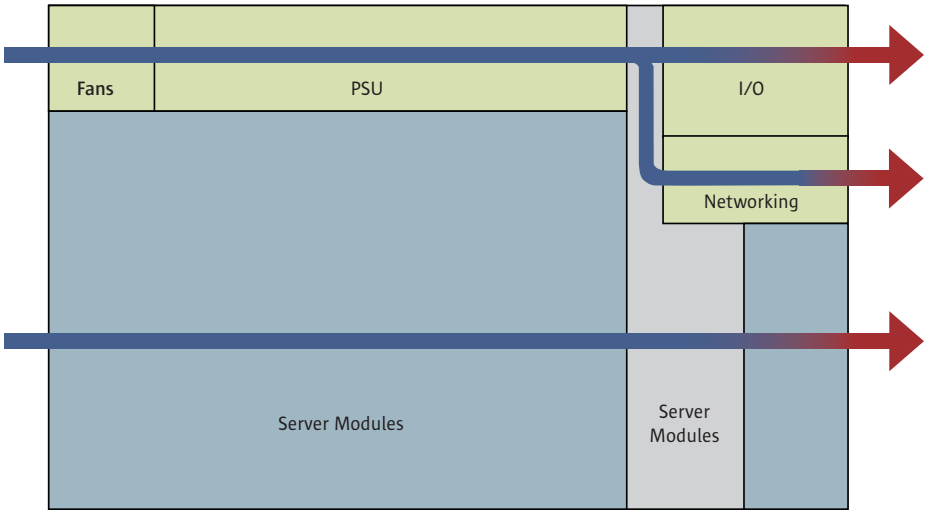

Figure 5. The Sun Blade 6000 Modular System is designed for low airflow resistance, increasing the effectiveness of cooling at low fan speeds.

HP documents its c7000 enclosure airflow in the document: "HP BladeSystem c-Class enclosure technology brief," available at: http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00816246/c00816246.pdf. Sun's experimentation showed that the actual I/O module airflow is more like that represented in Figure 6.

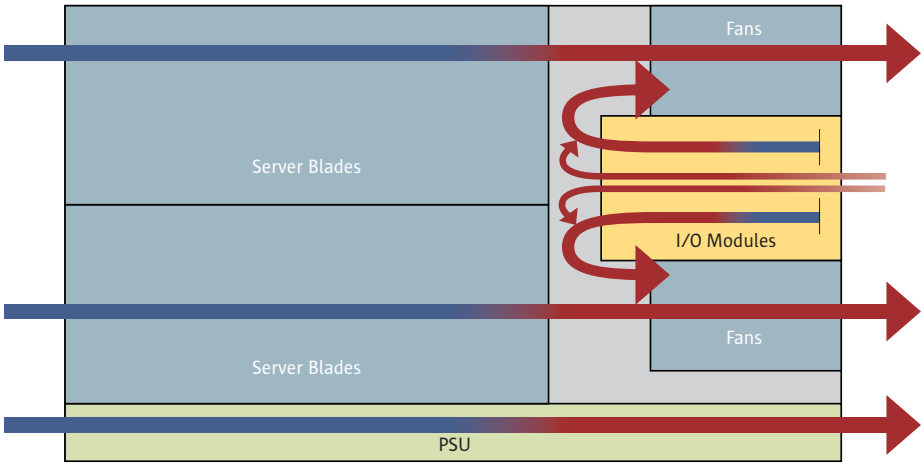

Figure 6. The HP BladeSystem c7000 enclosure uses an inefficient reverse airflow to cool its I/O and interconnect mechanisms, as well as recirculating external exhaust air.

Maximum Cooling Capacity

The Sun Blade 6000 Modular System offers high-efficiency cooling that supports the thermal profile of some of the highest-performing processors available today, with sufficient headroom to support even greater cooling requirements expected in the future.

The system supports most stringent of the manufacturers' thermal specifications, which allows Sun to deliver the full performance of today's dual and quad-core, 120 Watt processors from AMD and Intel. Sun does not resort to CPU throttling in order

to reduce processor cooling requirements. Customers wishing to deploy the highest-performing CPUs in their server modules today can utilize the full power of their processors.

The increasing use of virtualization has pushed memory requirements higher, and large amounts of memory also draw more power and require more cooling. Sun designed today's server modules with 8 DIMM slots per processor socket, spaced for adequate cooling at low airflow volumes. The headroom in the Sun Blade 8000 Modular System's cooling system allows it to support a total of 16 DIMM slots for current two-socket blades (up to 64 GB) and higher total DIMM counts in future systems.

For applications that don't require a large memory footprint, customers can populate all eight DIMM slots with lower-density memory. This allows them to take advantage of lower memory prices for less-dense DIMMs, helping reduce both power and cooling costs.

Whether you're a customer pushing the performance envelope or not, the ability of the system to manage cooling at low fan speeds for today's processors and memory gives even greater headroom for handling tomorrow's requirements with even more demanding temperature profiles.

Temperature-Based Cooling

The airflow and mechanics of the Sun Blade 6000 Modular System's cooling subsystem are designed to support the needs of today's and the future's high-performance processors. The way in which Sun manages the cooling subsystem contributes even more to the system's efficiency.

The system's main cooling fan speeds are controlled based on temperature sensors, which helps to minimize power and maximize cooling efficiency. Depending on the hardware and software configuration, extremely low airflow in terms of Cubic Feet per Minute (CFM) per processor socket is achievable in typical datacenter deployments.

All of the system's fans are hot-swap, N+1 redundant. This redundancy, combined with temperature-based control, allows for normal low-power, low-RPM operation, even if a fan has failed. The IBM BladeCenter H raises fan speeds following a fan failure regardless of temperatures. According to IBM's tests, the HP BladeSystem c-Class chassis must run at elevated fan speeds in order to cool the chassis under normal operating conditions.

Source: "IBM BladeCenter vs. HP BladeSystem, Setting the record straight on power and cooling," IBM Systems & Technology Group, January 2007.

Reduced Power Consumption

More efficient cooling means less power spent on the cooling subsystem. Sun has sized the Sun Blade 6000 Modular System's cooling fans so that, under normal operation, they can operate at low speed, above the range where they become inefficient, but

below the range where significant amounts of power are needed to increase airflow (Figure 7). Cooling subsystem power consumption under normal operating loads is approximately 70 Watts, with a maximum power consumption of 380 Watts. Compare this to a range of from 150 W to 1.2 kW in the HP BladeSystem which, according to the IBM report, may not even supply enough airflow to cool 120 Watt quad-core Intel Xeon processors, let alone maintain low enough DIMM temperatures to minimize memory errors. Even IBM did not support 120 Watt AMD Opteron processors at the time this document was prepared.

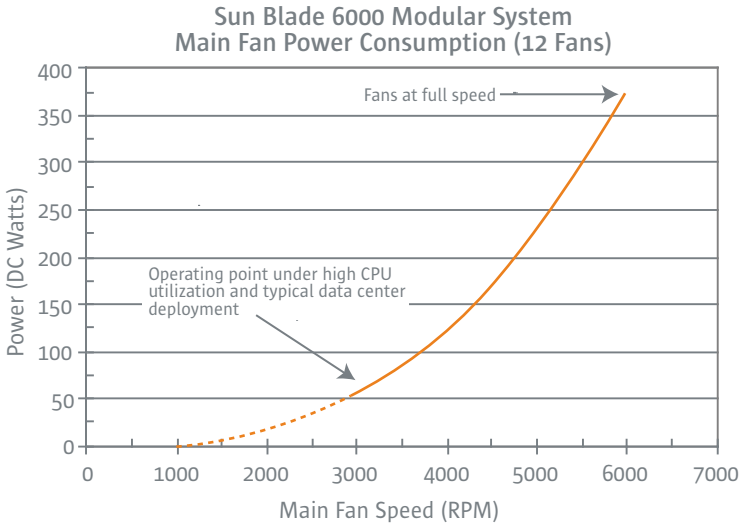

Figure 7. The Sun Blade 6000 Modular System operates in an ideal fan speed range, consuming approximately 70 Watts under normal conditions.

Processor Leakage Power

For more information on the relationship between processor leaking power and temperatures, please refer to: "Thermal Performance Challenges from Silicon to Systems," Intel Technology Journal, Q3 2000.

With today's advanced processor manufacturing technologies, processor leakage power has become a significant fraction of total processor power consumption. Leakage power is waste power that increases with temperature. The efficient airflow of the Sun Blade 6000 Modular System allows it to operate processors at lower temperatures, which in turn allows the processors to draw less current. Lower temperatures also have a favorable impact on both component and system reliability.

Power Management Features

Finally, The Sun Blade 6000 Modular System has intelligence to reduce CPU and memory power when possible during idle or low workload periods. This, combined with power supply efficiencies of up to 90 percent, help to contribute to the system's overall low power consumption.

Ahead Today, Ahead Tomorrow

The Sun Blade 6000 Modular System is a high-efficiency blade system that supports some of the fastest and most powerful processors available today, with headroom that allows it to accommodate the next generation of processors as they come to market. With Sun, you get the full power of the processors you purchase, because the Sun Blade Modular System is built to support Intel Xeon Thermal Profile A with minimum probability of processor speed throttling.

If you want to use the same 80 Watt AMD Opteron and Intel Xeon processors supported in HP and IBM blade systems, Sun supports these plus the extremely power-efficient UltraSPARC T1 processor. An eight-core UltraSPARC T1 processor that supports 32 concurrent threads sips only 70 Watts of power, giving it extremely high performance per Watt for throughput-oriented workloads.

If you need the fastest, most powerful processors available today, the Sun Blade 6000 Modular System supports two-socket server modules that support some of the fastest 120 Watt processors on the market today. Customers can choose between the quad-core Intel Xeon 5300 “Clovertown” series processors (X5355), and dual-core AMD Opteron 2220 series processors (3.0 GHz 2222SE).

Virtualization is a key technology used by IT organizations constrained by their space, power, and cooling limitations. Consolidating applications from multiple, less powerful servers onto platforms such as the Sun Blade 6000 Modular System requires not only processing power and low power consumption, but also large amounts of memory. The Sun Blade X6220 and X6250 Server Modules each support up to 64 GB each, delivering the memory capacity that virtualization applications demand.

With support for today’s processors and a “future-proof” roadmap supported by efficient power and cooling infrastructure, with Sun you start ahead, and stay ahead.

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