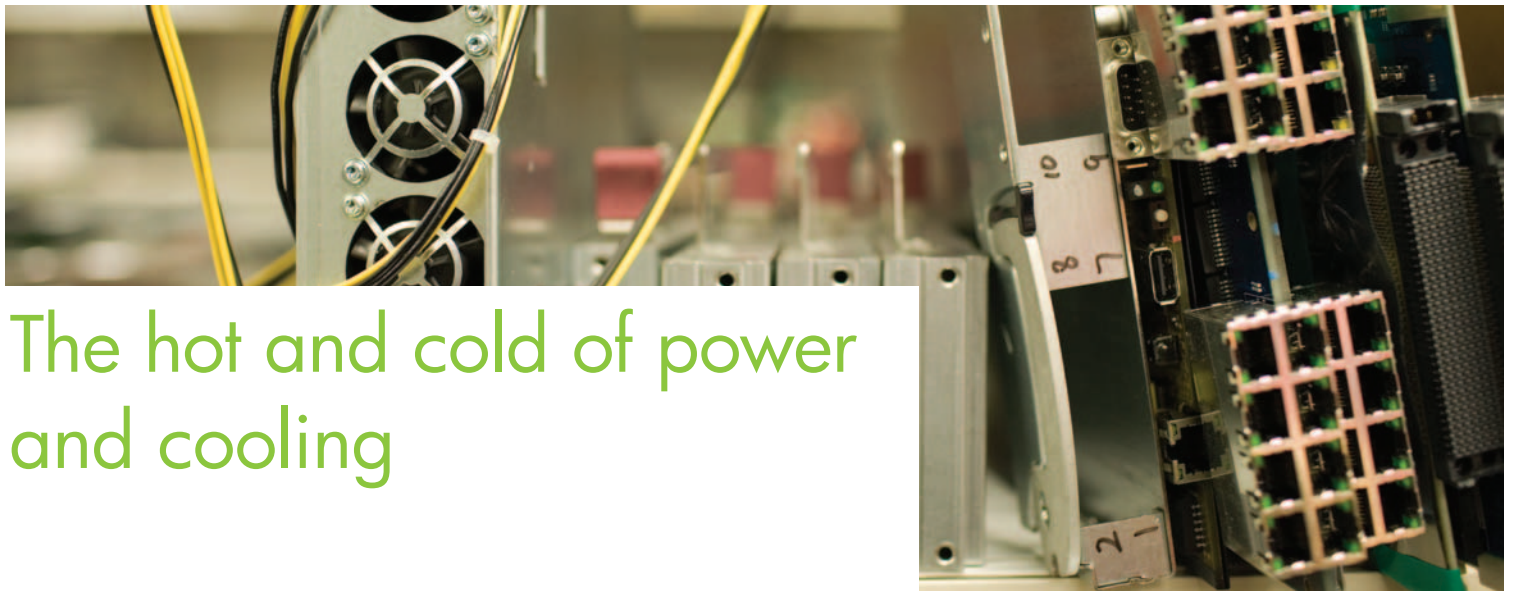


## Control power and cooling for data center efficiency

HP Thermal Logic technology  
An HP BladeSystem innovation primer



# The hot and cold of power and cooling

## The growing power and cooling problem

In the past, more data center performance was the goal. Power and cooling costs were just the price you paid for it. As energy costs skyrocket, processor and memory technologies have made performance the abundant resource, while power and cooling are at a premium. As server density rises, so do power requirements. As power increases, so does heat output, and already, the inability to power and cool data centers effectively is preventing many companies from achieving their IT goals.

## Density accelerates the issue

Power and cooling are issues regardless of form factor. However, increased server and processor density has accelerated the demands. Today, data center power density is increasing an average of 15 percent-20 percent a year. Customers using blade servers are simply some of the first to recognize critical power and cooling issues due to higher physical density.

## Paying for power

Over the last decade, server power costs have more than doubled, placing more stress on cooling and power infrastructures. According to the American Society of Heating, Refrigerating and Air-Conditioning Engineers, average server power densities have increased ten times in the last ten years. Data centers are seeing annual expenses—just for cooling—reaching into the multi-million dollar range. So every watt conserved provides real cost savings back to the business.

## How big is the burden in actual dollars?

Take 100 server racks full of rack-mount servers. Each rack that requires 12 to 13 kilowatts, uses—1.3 megawatts of power for the servers. The power for cooling to remove the heat generated is almost equal to that dissipated by the IT hardware itself. So the air conditioning will need another 1.3 megawatts of power. With the cost of electricity today, 1.3 megawatts at 10 cents a kilowatt-hour for a 24/7 operation is approximately \$1.2 million per year. This is quite significant. And the pressure to reduce it is becoming urgent.

## The power, heat, and cooling equation

To meet the requirements and limitations on power and cooling for each data center, it's important to consider the thermal footprint of each data center or server room by figuring

- How much critical load can you power?
- How much can you cool before you start to have problems like downtime or failures?
- How much computing capacity you need vs. power/cooling capacity you can't exceed before you incur the expense of overhauling the data center?

Unfortunately, many data centers are now stuck in a heat loop: Creating heat by powering cooling to offset heat dissipated by servers—creating new heat to get rid of existing heat. This is a problem regardless of platform—rack, tower, blade—all data centers have to address it. In fact, a Google® engineer warned that, if the performance per watt of today's computers doesn't improve, the electrical costs of running them could end up exceeding the initial hardware price tag.<sup>1</sup>

<sup>1</sup> Power could cost more than servers, Google warns CNET, Dec. 9, 2005  
By Stephen Shankland If you can't beat physics—use it

We can't change physics—so the need to balance all physical elements of heat, performance, density, and power becomes even greater.

That's why HP developed Thermal Logic technology, an innovative technology strategy built in to the next-generation HP BladeSystem that gives users a controllable balance between power and cooling to boost data center energy efficiency.

#### The impact of power and cooling

- In many data centers, electricity now represents as much as half of operating expenses.<sup>2</sup>
- Modern computing hardware requires about 3 square feet of cooling infrastructure for every square foot of floor space devoted to computers [...] that's six times the ratio of 10 years ago.<sup>3</sup>
- The average power consumption per server rack has doubled in the past three years.<sup>4</sup>
- 50 percent of the cost of a data center is associated with [...] expensive power and cooling equipment that is needed to support the computers.<sup>5</sup>
- The average annual utility cost for a 100,000-square-foot data center has reached \$5.9 million (Source: Edward Koplin, a principal at engineering firm Jack Dale Associates).<sup>6</sup>

## HP Thermal Logic technology—saving watts, saving money

#### Advanced capabilities for power and cooling control

To face growing concerns about rising heat and energy costs, HP set an aggressive goal to give our customers the ability to control power and cooling as a resource to optimize energy efficiency for any workload. You're probably familiar with server virtualization—the pooling and sharing of compute resources. Now we are virtualizing power and cooling. HP Thermal Logic technology achieves that goal with multiple levels of innovations, integrated into the HP BladeSystem enclosure and core capabilities to control and optimize power and cooling.

HP Thermal Logic gives you the unique ability to monitor, pool, share, and match power use to demand; balance performance, power, and cooling, according to the task at hand and cap power and cooling levels at the most efficient level for the required level of performance. You can even set power and cooling thresholds for the highest level of performance or the most efficiency, or initiate cooling and control cooling levels automatically to react to and remove heat. All for the most sophisticated control of power and cooling available.

#### Turning density into an advantage

Density, once a barrier to cooling, is now turned into an advantage with HP Thermal Logic technology like HP Active Cool fans and the HP PARSEC architecture. With these innovations, server blades get more cooling airflow where it's needed most and use less power to do it than traditional rack servers. In fact with HP Thermal Logic technology an HP BladeSystem enclosure requires up to 50 percent less airflow and up to 70 percent less power for cooling than the equivalent number of rack servers all while taking up less valuable rack space.

#### HP BladeSystem infrastructure delivers a constant stream of benefits

Regardless of the configuration, an HP BladeSystem delivers time and energy savings because it's always more efficient to power and cool, always less time-consuming to maintain, always easier to change, and always less of a burden on other domains and the rest of the data center.

#### Focused cooling technology avoids waste

In developing HP Thermal Logic, we expanded our view of power and cooling beyond the system or rack level to the whole data center. Every element in the data center has an effect on all the other elements, so forcing an entire blade enclosure to run at max cooling capacity just because of one high-powered blade affects airflow in the adjacent racks and rows as well as wasting power. By using a multizone architecture and multiple sensors in each enclosure, HP BladeSystem distributes power and cooling control through areas of widely varying power densities. Compared to the fans of traditional servers, HP Thermal Logic technology requires 50 percent less airflow and 70 percent less power to cool the same number of server blades.

This approach dramatically drops the costs of doing business. So your data centers will be more reliable and use fewer resources while they power businesses of today.

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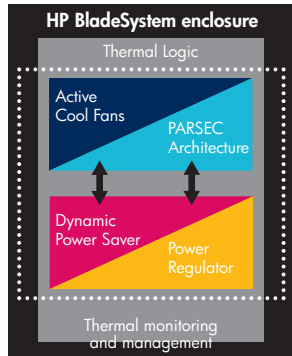
<sup>2</sup> Power Surge. The heat is rising—and costs, too—as tightly packed servers consume gobs of electricity, InformationWeek, Feb. 27, 2006  
By Darrell Dunn

<sup>3</sup> Power Surge. The heat is rising—and costs, too—as tightly packed servers consume gobs of electricity, InformationWeek, Feb. 27, 2006  
By Darrell Dunn

<sup>4</sup> Power Struggle; Increasing power demands in data centers are stressing both power distribution and cooling systems. Here's how IT managers are coping, Computerworld, Mar 30, 2006, By Robert L. Mitchell

<sup>5</sup> Redefining COOL; Better energy management could lead to cooler data centers that consume 50 percent less power, says HP's Chandrakant Patel, Computerworld, Oct. 31, 2005, By Robert L. Mitchell

<sup>6</sup> Power Surge. The heat is rising—and costs, too—as tightly packed servers consume gobs of electricity, InformationWeek, Feb. 27, 2006  
By Darrell Dunn



**An environmental enclosure**

With HP Thermal Logic technology built in, the new HP BladeSystem c-Class was designed with power conservation and maximum cooling in mind—offering more performance per kilowatt used. With more servers in a rack, you use the same or less power and cooling, and the consolidated design uses fewer parts. This higher density leads to fewer cables to obstruct airflow with enclosures and racks. So you need less cooling per square foot in your data center. When you use less power, you also generate less heat, lower your air-conditioning needs, reduce the number of racks you use, and, consequently the space required.



## Power and cooling technology steeped in innovation

**Instant insight to all thermal data**

Hundreds of embedded sensors placed throughout the enclosure enable HP Thermal Logic's monitoring and management. These report temperature data to the HP BladeSystem Onboard Administrator and HP Systems Insight Manager. With this thermal monitoring, it's simple to actively track the heat output for each enclosure in every rack, the air temperature in and out, and server power draw. This gives you the insight you need to match your system performance demands, while balancing set temperature thresholds—manually or automatically. You choose the level of control you need to balance power, heat, density, and performance.

**Pooled power distributed as shared resources**

HP Dynamic Power Saver improves power usage by only using the power supplies you need to match the requirements of your consolidated infrastructure. Since power supplies are most efficient running at higher loads, this keeps them working at their most efficient levels while the power supplies remain redundant. The HP Dynamic Power Saver feature runs continuously in the background, pooling power distribution to maintain system performance at higher application loads, and to provide power savings at lower application loads.

Rounding out our strategy for maximized power distribution, HP Power Regulator works at the processor level to more closely match the processor power consumption to the workload. Together, HP Dynamic Power Saver increases power supply efficiency—saving energy at the same time that HP Power Regulator reduces processor power consumption to save even more energy.

**HP Active Cool fans for efficient cooling**

HP Active Cool fans are an innovative new design that can cool 16 blades using as little as 100 watts of power. Its design is based on aircraft technology that generates fan-tip speeds up to 136 mph with high pressure and high airflow while using less power than traditional fan designs.

With 20 patents pending, these revolutionary fans meet a number of data center requirements:

- The most energy-efficient airflow
- Move enough air to cool just the components that need it
- Powerful enough to pull cool air through the blades and enclosure
- Half the noise output of equivalent rack-mount servers.
- Lower power consumption by only using the number of fans needed to maintain preset cooling thresholds
- Easily scale to even the most stringent future roadmap requirements

## AMD PowerNow!™ technology with Optimized Power Management<sup>8</sup>

- Provides performance on demand by dynamically adjusting performance based on CPU utilization. Systems run at optimum performance and power levels, reducing electricity costs while maximizing IT dollars
- Better platform power consumption enables servers and workstations to run cooler and more quietly
- Can reduce CPU power at idle by 75 percent

## Intel Xeon processor™ with Demand Based Switching Technology<sup>9</sup>

- Reduces utility costs by up to 24 percent when processor utilization is low
- The power-efficient DDR2-400, memory-based subsystem offers higher performance, lower power consumption, and robust reliability features over prior generations of DDR-based memory technologies

## HP PARSEC architecture for centralized cooling done right

HP Parallel Redundant Scalable Enterprise Cooling (PARSEC) architecture is a hybrid model for cooling that combines the best features of both local and central cooling. Enclosures are divided into four zones with fans located in each to provide direct cooling for blades in that zone, and redundant cooling for all others.

Because server blades require different cooling than storage blades, the cooling scales appropriately to the infrastructure elements inside the enclosure—even when you have different types of blades in multiple cooling zones. When combined with HP Active Cool fans, you are free to create different cooling configurations easily. The adjustable fans are hot-pluggable and can be swapped in and out to adapt airflow effectively across the architecture. This is centralized cooling done right.

## HP's "Cool Team" tackles heat

Founded in 1996, the Cool Team is a community of engineers across HP that forms a virtual team to educate each other in the power and cooling challenges and trends facing IT and the data center. To justify their moniker, the Cool Team has focused their energies on innovative ways to dissipate heat. Their goals were to stay ahead of the industry, and to funnel research ideas and technologies at HP Labs out to the divisions and into customer environments.

The results were equally cool. Some of the lab inventions they worked with range from ink-jet pumps that spray coolant on hot chips to more efficient designs for computer room air-conditioning systems.

## HP Thermal Logic facts

- HP BladeSystem cuts annual power costs by 33 percent compared to 1U rack-mount servers<sup>7</sup>
- Consolidated, optimized design uses fewer power-consuming parts
- Ultra-efficient power systems save 30 percent in wasteful electrical usage
- Up to 50 percent less airflow to cool 16 servers
- Up to 70 percent less cooling power compared to 16 1U servers
- Up to half the noise level
- HP Active Cool fans reach speeds of 18000 rpm x 2.5" blade = 136 mph tip speed
- One HP Active Cool fan can cool 5 typical 1Us at 25C

## Partner innovations enhance energy thriftiness

Adding to the energy savings of an HP BladeSystem, technologies and expertise from industry-leading processor partners like AMD and Intel help to solve power and heat issues. We've leveraged their energy-thrifty innovations to improve the efficiency of HP blades with dual-core and multi-core CPUs that give you a performance boost with no power drain.

<sup>7</sup> Based on the following configurations HP DL360 G5: 2x 36 GB 10k RPM HDDs, 4x 512MB DIMMs, 2x 2.6 Intel Woodcrest HP BladeSystem cClass: 10 fans, 2 Cisco switches –14 blades with 2x 2.6 Intel Woodcrest, 4x 512MB DIMMs, 2x 36GB 10k RPM HDDs –2 blades with 2x 2.23 Intel Woodcrest, 4x 512MB DIMMs, 2x 36GB 10k RPM HDDs Power required for cooling equals 50 percent of server power Cost per KW/hour is assumed to be \$0.10 per KW/hour 22 percent power savings multiplied by 1.5 for additional A/C savings, for total of 33 percent savings Savings will vary based on workload and configuration

<sup>8</sup> [http://www.amd.com/us-en/0,,3715\\_12353,00.html?redir=CPPN00](http://www.amd.com/us-en/0,,3715_12353,00.html?redir=CPPN00)

<sup>9</sup> [http://www.intel.com/business/bss/infrastructure/enterprise/power\\_thermal.pdf](http://www.intel.com/business/bss/infrastructure/enterprise/power_thermal.pdf) "Addressing Power and Thermal Challenges in the Data center", Intel, 2005

## HP takes a holistic approach to power and cooling

We look at the issue of power efficiency from the processor to the data center to find ways to give you the most performance and density with the lowest power usage.

### ENCLOSURE AND RACK

- Instant thermal monitoring for real-time heat, power, and cooling data
- HP Active Cool fans based on patented HP technology to optimize airflow, acoustics, power, and performance
- HP PARSEC architecture for parallel, redundant, scalable airflow design
- HP Modular Cooling system with water-cooled rack technology for 3x standard cooling per rack with no heat load added

### SERVER BLADE

- Low-heat dual and multi-core processors
- HP Power Regulator adapts the processor power to the application performance needs
- HP Dynamic Power Saver shift power load for maximum efficiency and reliability, while retaining full power-supply redundancy
- Integrated Lights Out (iLO) controls speed stepping to regulate power consumption
- Virtualization at the machine level for more work per watt

### DATA CENTER

- Holistic services approach includes HP Thermal Modeling and data center efficiency improvements
- Quick assessment service establishes basic relationship of the system
- Intermediate assessment deals with air conditioning, impact of obstructions, and airflow
- Comprehensive assessment looks at dynamic fluid flow and modeling techniques

### HP Smart Power and Cooling services help you get the most from your data center

HP Smart Power and Cooling services can help you make your new or existing data center more compact and more energy-efficient by planning the placement of computing resources, better configuration of cooling systems such as air-conditioning and vent tile placement. Taken together, these services can help you better manage growth and avoid power-and-cooling-related system failures.

#### HP Modular Cooling System

The HP Modular Cooling system is the innovative self-cooled rack for high-density deployments in the data center. HP's new cooling technology makes possible the deployment of up to 30KW in a single rack, bringing together hardware densities and power consumption levels that have been difficult, if not impossible, to cool previously.

HP Modular Cooling system is designed to complement the existing conventional data center cooling by adding computing power without adding to the current heat load in the data center. In addition, by packing three times the KW capacity of a standard rack, the MCS will extend considerably the life of your data center.

### HP's commitment to a steady stream of innovation

As a breakthrough developer for automated, managed power-and-cooling technology, and blade infrastructure innovation, HP's Cool Team will continue its cross-organization collaboration. Working across hardware, storage, software, services, and HP Labs, our goal is to anticipate and satisfy your changing environmental needs.

The foundation for our work is always provided by the strengths of HP—world-class engineering, industry-standard technology, industry-standard pricing, and world wide sales and support.

And our closed-loop process for total customer experience provides an open feedback and input mechanism that translates into new and innovative technologies to overcome the ever-changing landscape your IT data center must maneuver.

## For more information, please visit

#### HP BladeSystem Evaluation Center

Browse this complete resource so you can advise and direct your prospects here to help them evaluate, plan, integrate, use, and maintain their HP BladeSystem solutions. The HP BladeSystem Evaluation Center contains interactive demos, videos, webinars, TCO calculators, detailed technical data, and more. It's simple, flexible, and easy-to-use— just like HP BladeSystem itself.

[www.hp.com/go/bladeSystem/evaluate](http://www.hp.com/go/bladeSystem/evaluate)



## FAQ

### **Q: What is HP Thermal Logic Power and Cooling?**

A: HP's innovative new technology strategy for the new HP BladeSystem c-Class offers built-in thermal instrumentation and controls to adjust and shift power load and thermal control automatically, based on changes in workload demand and environment. This gives you the ability to raise system performance without exceeding the power and cooling capacity of your data center.

### **Q: How is this different from the power packs and the fans built into the enclosure?**

A: Those are mechanical systems designed to deliver air and energy to computing systems. HP Thermal Logic gives you new ways to use those systems and others to reduce power use, lower the risk of overheating, and still get the most performance out of your servers.

### **Q: Do any or all of the HP Thermal Logic technologies and capabilities come standard with the HP BladeSystem, or is this a premium capability that I must purchase?**

A: All of the key capabilities of HP Thermal Logic technology are built directly into the HP BladeSystem enclosure. There is nothing additional to buy or install. Additional items such as water-cooled racks (part of HP Modular Cooling Systems) or Smart Power and Cooling services can be purchased to help increase the thermal efficiency across multiple enclosures or a combination of rack configurations for even more cooling efficiency within your data center.

### **Q: Will I need an HP technician or consultant to implement the capabilities and technologies associated with HP Thermal Logic or can I do it myself?**

A: You can easily set your own power, temperature, and performance thresholds; configure alarms and automatic actions; and a host of other HP Thermal Logic functions. However, HP does offer a variety of Smart Cooling services that can help you get more out of HP Thermal Logic functionality.

### **Q: Is Thermal Logic something I can add/extend to my existing p-Class environment?**

A: HP Thermal Logic is a new innovation that was built into the design of the new HP BladeSystem c-Class. It is not a traditional power/cooling component that can be added on to existing p-Class enclosures.

### **Q: How does HP Thermal Logic compare to the power and cooling capabilities of IBM's BladeCenter H?**

A: BladeCenter H has 4 switch bays that do not have hot-plug cooling behind the 12 small power supply fans. With only one blower zone and two total blowers, the design is not as robust. Without zoned cooling, you have to pay for the worst load all of the time.

### **Q: How will I be able to manage and stay in control of what's happening if it's all dynamic and automated?**

A: While HP Thermal Logic gives you the option to use automated presets, you're also free to choose manual control. Plus, you get far more visibility into the power and cooling of your HP BladeSystem than ever before—all seamlessly integrated into unified HP management systems for easy tracking and reporting.



To learn more, visit [www.hp.com/go/bladesystem/evaluate](http://www.hp.com/go/bladesystem/evaluate)

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