



ECO COMPUTING FOR **GOVERNMENT**

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Table of Contents

Introduction	1
Delivering Both Economical and Ecological Value	2
Sun's Results with Datacenter Efficiency	3
Understanding the Terrain	4
Improving Server Efficiency and Performance	4
Enhanced Scalability and Protection with the Solaris 10 Operating System	6
Increasing Utilization While Delivering Higher Throughput	6
Secure Isolation with Sun Logical Domains	7
Securing Workloads with Solaris Containers	7
Driving Efficiency in Storage	8
Desktop Computing—A Hidden Source of Inefficiency	8
Reducing Datacenter Infrastructure Costs	9
Three Simple Steps to Success	10
Sun Eco Services Suite	11
Conclusion	12
For More Information	13

Introduction

The ecological and economical impact of datacenter IT systems has become a rising concern throughout the last decade. With a billion people participating online today, the network consumes more than 100 billion kW of electricity and costs approximately \$7.2 billion annually in utility bills.

According to the Uptime Institute, datacenter power consumption doubled from 2000 to 2005. In fact, according to FCOM, an association of datacenter experts, some organizations are in danger of running out of power in their datacenter within the next five years. Rising energy costs and the increased power requirements of today's datacenters have made power consumption a key factor in IT planning and budgeting. Some analysts predict that IT infrastructure power usage will soon cost more than the hardware itself. In addition, the continued increase in IT power requirements has brought forth concerns about the ecological impact of IT power consumption.

Ecological responsibility also extends to the end of life of IT equipment. The European Union (EU) Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) currently enforces the safe disposal or reuse of hazardous components in IT systems, and similar regulations are likely to follow in other regions and countries.

As regulators of pollution and supervisors of environmental impact, government agencies must set a good example for ecologically responsible IT usage. Citizens look to the government to take the lead in regulating and adhering to eco responsible legislation and policies. Gartner states that "By 2010, environment-related issues will be among the top five IT management concerns for more than 50 percent of state and local government organizations in North America, EMEA and Australia (0.7 probability)¹."

Drivers that will urge government action come from three different arenas:

- **Political** – Climate-change discussions and environmental issues are increasingly present on political agendas around the world, putting pressure on policymakers to commit to green IT solutions that reduce environmental impact
- **Legislation and regulation** – Existing and future regulations will focus on equipment procurement, disposal, and reduced emissions
- **Cost reduction** – The increasing cost of energy and compliance with environmental regulations will bring green IT to the forefront as a means to reduce government IT costs

¹ "Why Government CIOs Need to Care About 'Green IT'," Andrea Di Maio, Gartner, 4/19/07

The green IT trend and political pressures will create a sense of urgency for government organizations, forcing them to lead rather than lag behind commercial businesses. Improving the ecology of government datacenters can also generate significant cost savings through lower operating costs and improved system utilization. And, of course, green IT can help reduce the impact on the environment by reducing carbon emissions.

Rather than wait for political pressure to mount or for legislation or regulations to force a timetable for action, governments can take steps now and start enjoying energy savings as well as gaining political clout by showing leadership in this area.

Many government organizations, however, face challenges in transitioning to green IT and are looking to gain expertise and knowledge about what to change and how to optimize datacenter energy efficiency. Sun can provide government organizations a clear, actionable solution for deploying Sun's innovative, open, energy-efficient products. Governments can leverage the expertise of Sun and our partners to help reduce the energy consumption, IT footprint, and operating costs of their datacenters.

To help customers get the most from green IT, Sun has developed the Sun Eco InnovationSM Initiative. The program and its offerings are based on Sun's experience and process for driving energy efficiency in our datacenters and those of our customers. Sun expects to save \$3.4 million in utility costs in the U.S. in fiscal year 2008 as a result of our eco responsibility activities. In fact, Sun has already reduced annual carbon emissions across the company by 30,000 metric tons, which is equivalent to taking 782 cars off the road for a year.

Delivering Both Economical and Ecological Value

Datacenter efficiency can have a positive impact on the bottom line and help government organizations improve their public image. Specific benefits include:

- Reduced IT operating expenses, thus improving organizational budget constraints
- An IT infrastructure that is better performing, more flexible, easier to manage and, can adapt more readily to changing needs
- Enhanced security and availability with a consolidated IT infrastructure that helps reduce the risk of data theft, security attacks, and service downtime
- Improved relations with citizens and regulatory communities

These benefits are already being achieved by government organizations using Sun products and services. With help from SunSM Services, Michigan's Department of Labor and Economic Growth (DLEG) reduced IT costs across three agencies by more than \$500,000 per year. The DLEG completed a major datacenter consolidation in less than six months with no application failures affecting end users. The project also provided operational savings by increasing systems administrator productivity by 60 percent and decreasing the time to deploy new applications by 70 percent.

The Australian government also achieved big savings by consolidating its storage environment. As a result of government policy and workplace reform initiatives, the Department of Employment and Workplace Relations (DEWR) needed to increase the capacity of its storage backup infrastructure. After thoroughly considering its available alternatives, the DEWR opted to enhance its existing Sun StorageTek™ mainframe and server tape backup infrastructure with the newest generation of Sun technology. The StorageTek SL8500 modular library system delivers more storage space and greater performance in a 33 percent smaller footprint. The system uses approximately 60 percent less electricity and generates about 70 percent less heat, reducing operating costs, increasing reliability, and adding flexible scalability.

Sun's Results with Datacenter Efficiency

Sun recently completed a datacenter efficiency project that combined best practices in datacenter design with hardware consolidation using energy-efficient Sun Fire™ servers with CoolThreads™ technology. Sun generated the following returns in our datacenter in Santa Clara, CA:

- Reduced the number of servers by almost 50 percent while increasing compute power four times by taking advantage of the latest generation of Sun servers and Sun virtualization technologies
- Reduced storage devices by more than two-thirds while increasing capacity by nearly 250 percent with Sun virtualized storage solutions
- Consolidated more than 200,000 square feet of datacenter footprint down to 76,000 through optimized layout, enabling Sun to reduce real-estate costs and avoid \$12 million in datacenter facilities construction costs
- Cut power consumption by 61 percent through hardware consolidation and optimized power distribution and modular cooling, saving \$860,000 in nine months and avoiding supply restrictions from the grid
- Reduced carbon emissions by 3227 metric tons through hardware consolidation alone (the entire project is expected to reduce annual emissions by 4100 metric tons), helping support Sun's corporate social responsibility objectives

The project successfully demonstrated Sun's belief that what's good for the planet can also be good for the bottom line.

Understanding the Terrain

Before embarking on a project to improve energy efficiency, government organizations should understand the most common sources of inefficiency and how to address them. The environmental and economic costs in a datacenter are most often linked to the following primary factors:

- Inefficiency at a system level in terms of power consumption, resulting heat output, and footprint
- Low performance, meaning workloads could be run on fewer or smaller high-performance systems
- Low utilization of compute resources, meaning machines are using power and pumping out heat while doing little useful work
- Unaccounted costs in storage and desktop computing infrastructure
- Unoptimized datacenter layout and supporting infrastructure such as cooling and power systems

These factors can be addressed by designing the datacenter facility and IT architectures to optimize energy efficiency. The following sections provide an overview of Sun solutions and best practices that have been proven to achieve greater efficiency.

Improving Server Efficiency and Performance

Improving server efficiency and application performance can be as simple as replacing servers that are a few years old with new, more efficient models. In Sun's recent datacenter efficiency project, Sun retired almost 5000 servers, switches, and storage devices and was able to decrease utility bills by 61 percent. Energy-efficient Sun Fire T2000 servers were used to replace pairs of Sun Fire V880 servers. Each Sun Fire T2000 server could handle the same workload as two Sun Fire V880 servers while consuming a fraction of the power. The utility costs for running two Sun Fire V880 servers was approximately \$2600 per year whereas the new Sun Fire T2000 will cost only \$200 per year.

These striking improvements in energy efficiency are the result of recent advances in technology with UltraSPARC® T1 and T2 processors, which deliver dramatic reductions in power consumption while yielding big boosts in performance throughput. The UltraSPARC T1 processor offers up to eight cores and support for up to 32 simultaneous threads. With eight cores and 64 threads on one chip, the UltraSPARC T2 processor doubles the throughput of the T1 processor, enabling increased computational density while staying within variously constrained envelopes of power and cooling.

Previous generations of processor technology were focused on fast performance for single threads. However, memory access speeds have lagged behind processor performance gains, often resulting in fast processors that simply spend more cycles doing nothing. Worse still, idle processors continue to draw power and generate heat, exemplifying how frequency, which is measured in GHz, is a misleading indicator of real performance.

Unlike traditional single-threaded processors and even most current multicore processors, UltraSPARC T1 and T2 processors allow rapid switching between active threads as other threads stall for memory. Figure 1 illustrates the difference between Chip Multiprocessing (CMP), Fine-Grained Multithreading (FG-MT), and chip multithreading. The cores in an UltraSPARC processor are designed to switch between multiple threads on each clock cycle. As a result, the processor's execution pipeline remains active doing actual, useful work, even as memory operations for stalled threads continue in parallel. CMT takes advantage of CMP advances and adds a critical capability—the ability to scale with threads rather than frequency.

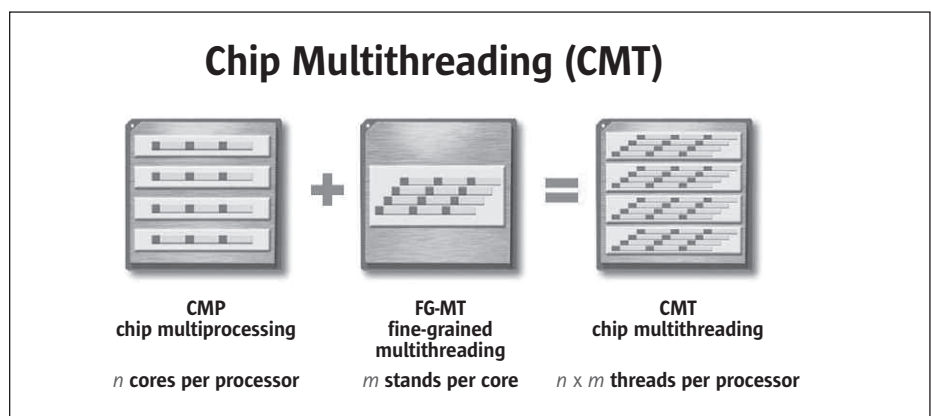


Figure 1. CMT combines CMP and FG-MT

Sun CoolThreads servers and blades powered by the UltraSPARC T2 processor are designed for virtualization and eco efficiency. With up to eight cores yielding 64 threads per system, they provide the flexibility and power of 64 virtual systems in a single server. These systems combine world-record performance with dramatic reductions in power, cooling, and datacenter space, enabling government organizations to deliver services to millions of online visitors and communities while saving millions of dollars through a virtualized, environmentally responsible datacenter infrastructure.

Specific benefits of Sun CoolThreads servers can include:

- Greater throughput in less space with up to 60 percent fewer systems in a consolidated infrastructure
- One-fourth the power consumption of competitive systems
- Greater security for Web services using integrated cryptographic accelerators in the UltraSPARC T2 processor to deliver encrypted Web transactions while maintaining high throughput
- Secure application isolation in consolidated systems via Sun Logical Domains and Solaris™ Containers
- Reduced management costs with fewer systems and highly automated tools

Enhanced Scalability and Protection with the Solaris 10 Operating System

Specifically designed to deliver high scalability for multiple workloads, the Solaris 10 Operating System (OS) takes advantage of the CMT processing capabilities of the UltraSPARC T2 processor. The Solaris 10 OS is aware of the UltraSPARC T2 processor hierarchy, which enables its scheduler to effectively load balance across all available pipelines. Even though it exposes the UltraSPARC T2 processor as 64 logical processors, the Solaris OS recognizes the correlation between cores and the threads they support, and provides fast and efficient thread implementation.

The Solaris OS offers enhanced reliability and scalability, and has been scaling to 64 threads since the introduction of the 64-way Sun Enterprise™ 10000 server nearly a decade ago. It offers substantial performance gains over competitive operating systems through innovative new features such as improved networking, memory placement optimization, virtualization, and Dynamic Tracing (DTrace) for performance analysis. Security software features available in the Solaris 10 OS, coupled with integrated cryptographic accelerators in the UltraSPARC T2 processor, offer increased protection while practically eliminating the performance penalty of secured Web services using Secure Sockets Layer (SSL).

Increasing Utilization While Delivering Higher Throughput

The proliferation of large numbers of even the most inexpensive servers is driving up costs for today's datacenter infrastructures. Server sprawl has created massive operational inefficiencies along with excessive power loads, heat generation, and space consumption.

Sun CoolThreads servers help consolidate workloads for greater efficiency and higher system utilization while also delivering high throughput. Virtualization technologies in Sun CoolThreads servers enable fine-grained division of multiple resources—from processing to virtualized networking and I/O. What's more, Sun's virtualization technology is provided as a part of the system, not as an expensive add-on.

“The Solaris 10 Operating System with [Sun] Logical Domains provides DigiTar with rock-solid fault isolation and stronger partitioning of server resources. These two qualities power the stability we need to ensure our customers receive business-critical communications 24 hours a day, 365 days a year and at a competitive price.”

—Jason Williams
COO and CTO
DigiTar

Secure Isolation with Sun Logical Domains

Sun Logical Domains technology lets organizations consolidate datacenter applications by dividing Sun CoolThreads servers into multiple logical servers that can securely isolate application services. This makes it easy to replace older, less efficient servers by simply moving the operating system, data, and applications to their own domain within a Sun CoolThreads server.

Each logical server’s operating system, data, and applications are partitioned to run independently of each other while sharing the processing and storage resources of the Sun CoolThreads server. It’s even possible to run multiple, different operating systems simultaneously, combining several small UNIX® and Linux servers onto one Sun CoolThreads server.

Multiple logical domains are created by the addition of a software layer called hypervisor, interposed between the operating environment and the hardware platform. Hypervisor abstracts the hardware and can expose or hide various resources, allowing administrators to specify resource partitions for Sun Logical Domains. Each logical domain is an independent, discrete system, separated from the others, with its own resource level specification.

Securing Workloads with Solaris Containers

Solaris Containers technology offers a low-overhead partitioning approach that combines fine-grained resource controls with the ability to securely isolate application workloads in separate partitions of the Solaris OS. When using Solaris Containers to isolate workloads, each application instance is deployed in its own secure zone with its own resources while sharing a common instance of the Solaris OS. Thus, Solaris Containers can help reduce administration overhead and increase government-grade security by reducing the number of operating system instances to be managed.

Each container includes a unique root file system, a shared read-only set of system executables and libraries, and whatever resources the root administrator assigns to the container at creation time. An administrator can boot or shut down individual containers as if they were separate operating system instances.

System resources allocated to a container are protected so that applications can run without concern about resource contention or security violations in other containers. Solaris Containers technology restricts the propagation of software faults to a single container using security isolation enforced by the Solaris Kernel. And best of all, Solaris Containers technology is included with the government-grade Solaris 10 OS at no extra cost.

Driving Efficiency in Storage

With data volumes growing exponentially, the cost of storing and managing data is a substantial factor in IT budgets. Today's IT managers are looking for ways to consolidate storage to optimize datacenter space utilization and save on power and cooling. More than ever, government organizations need to take a balanced infrastructure approach to storage challenges. Each application requires different performance, data accessibility, and capacity. The long-term energy costs associated with data archiving and retention must be taken into account as well.

Sun offers a storage infrastructure that takes advantage of the full breadth of Sun StorageTek technologies, from primary disk and disk virtualization solutions to tape virtualization and state-of-the-art tape automation products. Sun storage software solutions also enable key functions such as the ability to automatically move data from one storage device to another based on policies set by the user. New software options can also eliminate redundant data, thereby reducing the overall amount of data archived. All of these technologies can help maximize utilization and increase energy efficiency.

Today's electronic discovery and data retention requirements are also making tape solutions an important tool for minimizing the cost of long-term data archiving. While data stored on removable media uses virtually no energy, tape automation products use varied amounts of energy. Sun StorageTek tape libraries are up to 57 percent more energy efficient than competitive offerings. In fact, Sun has made energy efficiency a key design element, and our recent tape library offerings have reduced energy consumption by as much as 40 percent over previous generation libraries. In some cases, the amount of data that can be stored on a tape cartridge has quadrupled in the past five years.

Sun's storage solutions provide the means to address all of these key issues and help government organizations improve energy efficiency while reducing the cost of storing and managing data.

Desktop Computing—A Hidden Source of Inefficiency

Many government organizations fail to consider the total power consumption of the hundreds or thousands of desktop systems deployed outside the datacenter. Desktop systems with local storage also create a potential security threat, making it harder to control access to sensitive data.

Sun Virtual Desktop Solutions provide a centralized, virtual desktop environment that is secure, cost efficient, and resilient. This enables organizations to consolidate and virtualize complete desktop environments or individual applications and host them in the datacenter where they can be managed and maintained with greater security and efficiency. More efficient thin-client desktop devices can then be deployed instead of traditional fat-client desktops, which consume extra power and present potential security threats.

In addition to power savings, a centralized desktop environment also provides cost savings from administration efficiencies. Administrators can efficiently manage a few servers in the datacenter rather than trying to provide support for thousands of desktop devices. Setup of new user desktop environments for workgroups, departments, or agencies can typically be accomplished in minutes on the centralized server without requiring administrators to visit user office locations or even provide remote support.

Virtual desktop solutions including Sun Ray™ clients are Commercial Off-The-Shelf (COTS) products and enable rapid deployment in a prebuilt Sun Ray network. To minimize risk and speed deployment, Sun Services can help assess, architect, implement, and manage a solution tailored to government-specific requirements.

Benefits of Sun Virtual Desktop Solutions can include:

- Increased security for the desktop environment, reducing the threat of theft of sensitive data by removing all local information on desktop devices
- Improved efficiency for government employees by enabling session mobility from one device to another and by providing instant, flexible, and secure access to desktops and appropriate applications from any device or platform over the network
- Reduced administration costs with desktop data and applications consolidated in the datacenter
- Simplified emergency preparedness and business continuity for desktop applications and data

Reducing Datacenter Infrastructure Costs

A traditional raised-floor datacenter with up to 3000 pounds of server racks can cost as much as \$1 million to construct. With today's high-density equipment, however, the raised floor approach often provides inadequate cooling and results in hot spots within the datacenter. In addition, power and cabling for dense racks can be time consuming to configure when datacenter equipment is being moved or new equipment is being added.

Sun has designed a flexible approach to deploying datacenter power and cooling based on a modular architecture that can be easily replicated to enable rapid datacenter expansion. The architecture is based on the concept of pods, which are groups of servers and storage systems that can be served by a localized power and cooling infrastructure. These pods can then be easily replicated throughout the datacenter.

To take a video tour of the pods, go to:

sun.com/aboutsun/environment/media/datacenter_tour.xml

Sun's newly remodeled datacenter in Santa Clara, CA, uses a slab floor with an innovative power and cooling infrastructure based on some new concepts:

- **Hot aisle containment** – Two rows of servers are placed back to back and the space between the racks is sealed off to keep heat from circulating throughout the room. An intelligent cooling system monitors the temperature of the hot aisle and automatically adjusts fan speeds to scale the cooling capacity required for the hot aisle. This puts the cooling power where it's most needed and enables greater efficiency. If a fan scales back by 50 percent, it utilizes only one-eighth as much power
- **Spot cooling** – Overhead cooling units are located directly above a hot rack and can be moved as easily as the equipment
- **Overhead power bus** – An overhead power bus provides the ability to easily plug in power wherever it's needed

By replicating pods of servers along with their cooling and power infrastructure, government organizations can easily scale and adapt the datacenter infrastructure to the datacenter design.

Three Simple Steps to Success

In addition to products and services that help improve datacenter efficiency, Sun shares information about our approach and experience to help customers more quickly and easily achieve real results. The Sun Eco Innovation Initiative puts our best practices to work and delivers an open, actionable path to an energy-efficient datacenter while also saving time and reducing risk.

Sun's approach to eco efficiency is based on a proven, straightforward process with three simple steps:

- **Assess** – Sun experts help measure the current state of the datacenter to determine the efficiency and environmental impact of datacenter equipment and operations. The technical evaluation includes recommendations for improving cooling capacity, rack placement, air distribution, and other environmental factors that can impact operational costs and service reliability
- **Optimize** – Customers can upgrade older, inefficient systems to newer Sun systems that deliver improved performance and throughput as well as greater efficiency in space, power, and cooling. Sun can also recycle unused equipment to help reduce electronic waste
- **Virtualize** – Customers can achieve significant savings with Sun's end-to-end virtualization and management solutions. Sun Services' experts can also help government organizations get the most out of Sun's virtualization solutions to increase system utilization, bypass power and space limitations, and increase performance and security

The Sun Eco Innovation Initiative offers special promotions with up to 25 percent savings on eco-efficient Sun products combined with highly focused professional services. The program also includes free, environmentally friendly recycling or re-purposing of old equipment (both Sun and non Sun) along with safe data disposal.

Sun's offerings are packaged into Sun Eco Ready Kits, which include a specific blend of assessments, services, and breakthrough technologies.

Sun Eco Services Suite

For government organizations that want more support for their datacenter efficiency project, Sun has created a specific suite of services for site assessments, cooling efficiency design, and eco infrastructure optimization.

The Sun Eco Services Suite includes:

- **Sun Eco Assessment service for datacenter, basic** – This service evaluates a targeted group of equipment to determine how to maximize power and cooling efficiency. Customers receive a recommended plan for improving key environmental and space issues through a comprehensive review of energy consumption, rack design, space utilization, cooling system, and air distribution
- **Sun Eco Assessment service for datacenter, advanced** – This comprehensive service provides a technical evaluation of the customer's datacenter energy use, cooling capacity, rack placement, air distribution, and other environmental factors that can impact operational costs and reliable service. The service also includes recommendations for improving key environmental and space planning issues.
- **Sun Eco Cooling Efficiency service for datacenter** – This service can help customers optimize existing air conditioning infrastructure and air distribution to recover misused capacity and redirect it for improved hardware cooling and increased redundancy, thus helping to reduce capital and operating costs.
- **SunSM Eco Optimization service for datacenter** – This service provides both practical and direct assistance with the implementation of corrective actions outlined in the Sun Eco Assessment Service for Datacenter service. Customers receive multiple site assessments as well as ongoing technical support for rack cabinet selection and layout, hardware requirements, vendor coordination, and other options relating to facility improvement and maintenance

Conclusion

Changing the IT environment to improve datacenter efficiency may sound like a big undertaking that could pose significant challenges and risks. However, there's no need for government organizations to make the journey alone.

As an innovator and leader in datacenter efficiency and an experienced government contractor, Sun is in a unique position to help government organizations achieve real results. Sun brings an experienced team of talented professionals dedicated to the global government market—a team that understands the nuances of government business. Thus, Sun can deliver solutions specifically designed to address government priorities, and governments can leverage Sun's products and expertise to improve energy efficiency and reduce the ecological impact of their IT operations.

Sun's offering for eco efficiency includes a strong combination of products and technologies as well as services based on Sun's expertise gained through more than a decade of enterprise datacenter consolidation experience. Specific components of Sun's end-to-end solution for optimizing datacenter efficiency in government organizations include:

- Energy-efficient Sun servers and storage systems
- Virtualization technologies that can greatly improve system utilization
- Virtual desktop solutions that reduce power consumption outside the datacenter and help reduce electronic waste
- Service offerings that can help government organizations consolidate and virtualize their datacenters and implement best practices for improving efficiency through datacenter design
- A global product returns program that enables organizations to return end-of-life equipment to Sun for recycling, reuse, or proper disposal—including items subject to the WEEE Directive
- A community of like-minded partners who share Sun's commitment to eco responsibility and offer complementary solutions to help improve energy efficiency and reduce energy costs

Sun has also created an Eco Innovation Resource Center at sun.com/ecoinnovation to help customers get started quickly. The online resources range from tips for energy efficiency to power calculators, blueprints, white papers, and customer references.

By leveraging Sun's end-to-end offerings and the knowledge and expertise of seasoned government industry specialists, government organizations can generate both economical and ecological benefits from datacenter efficiency.

For More Information

You can learn more about how Sun can help government organizations deliver a more efficient datacenter with both economical and ecological benefits by visiting the following Web sites or contact a local Sun representative.

Website	Description
sun.com/government	Sun in the global government industry
sun.com/ecoinnovation	Sun Eco Innovation Initiative
sun.com/service/eco	Sun Eco Services Suite
sun.com/servers/coolthreads/overview	Sun Servers with CoolThreads technology
sun.com/processors/UltraSPARC-T2	UltraSPARC T2 processor
sun.com/storagetek	Sun storage solutions
sun.com/servers/coolthreads/ldoms	Sun Logical Domains
sun.com/solaris	Solaris OS
sun.com/datacenter/consolidation/virtualization/desktop	Sun Virtual Desktop Solutions

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