The Use of Virtualization in the Greening of IT
Sun's Eco-Innovation Initiative

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Practice Manager -
Sun Systems Virtualization Practice

Today's Topics

- Today's Eco Challenges
- Eco-responsibility @ Sun
- The Opportunities – Examples from Sun
- Sun's Eco-Innovation Initiative
- Helping Customers - Virtualization Technologies and Eco-Services

What's Going On In The Data Center?
Demand explosion and Supply Limits Are Colliding...

↑ Demand
↑ Users
↑ Services
↑ Access

↑ Power
↑ Costs
↑ Space
↑ Heat
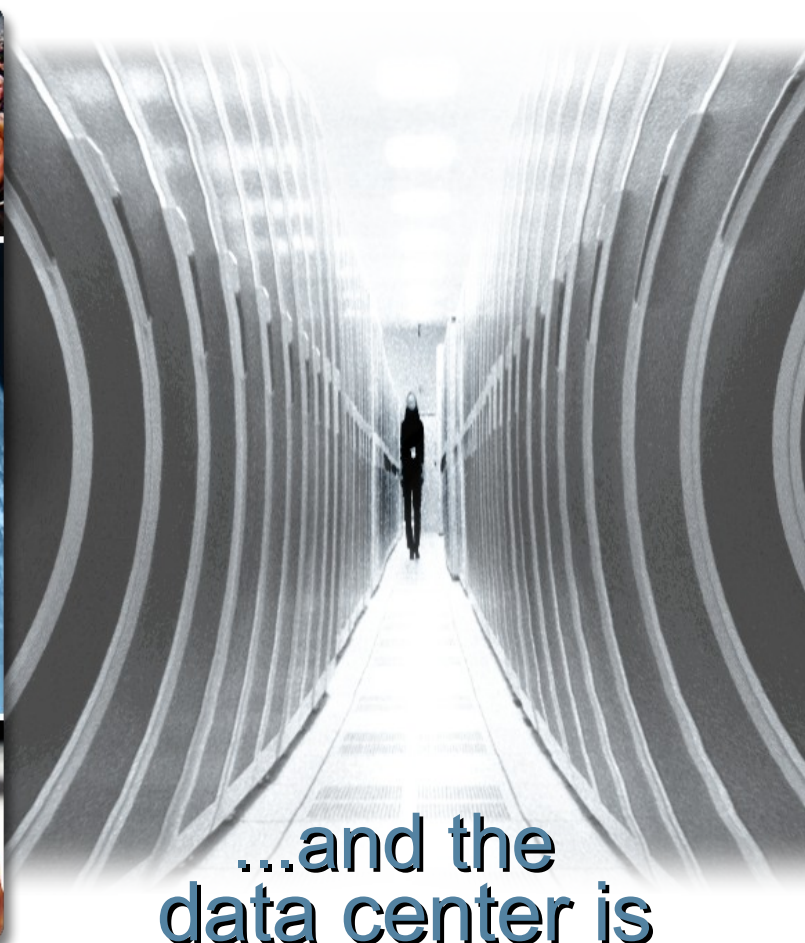
...and the
data center is
right in the middle!
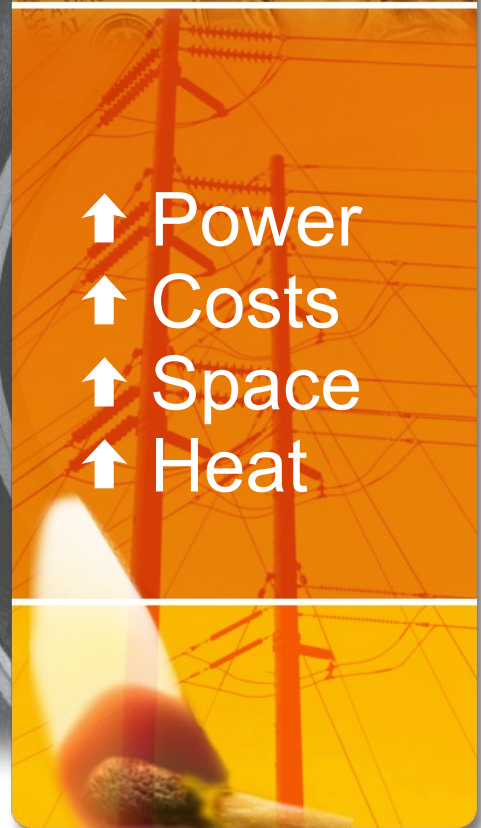
What Customers Are Telling Us

Power and cooling constraints are very real issues

Energy costs are draining the bottom line

Disaster recovery planning is non-negotiable

Sprawling IT infrastructure is increasingly hard to manage

Ability to deploy new services is critical to remain competitive

Underutilized, inefficient systems are limiting business growth

Eco-concerns

Power

RoHS

E-peat Standards

Floorspace

CO^2 Emissions

Recovery/ Recycle

CO^2 Footprint

Air Conditioning
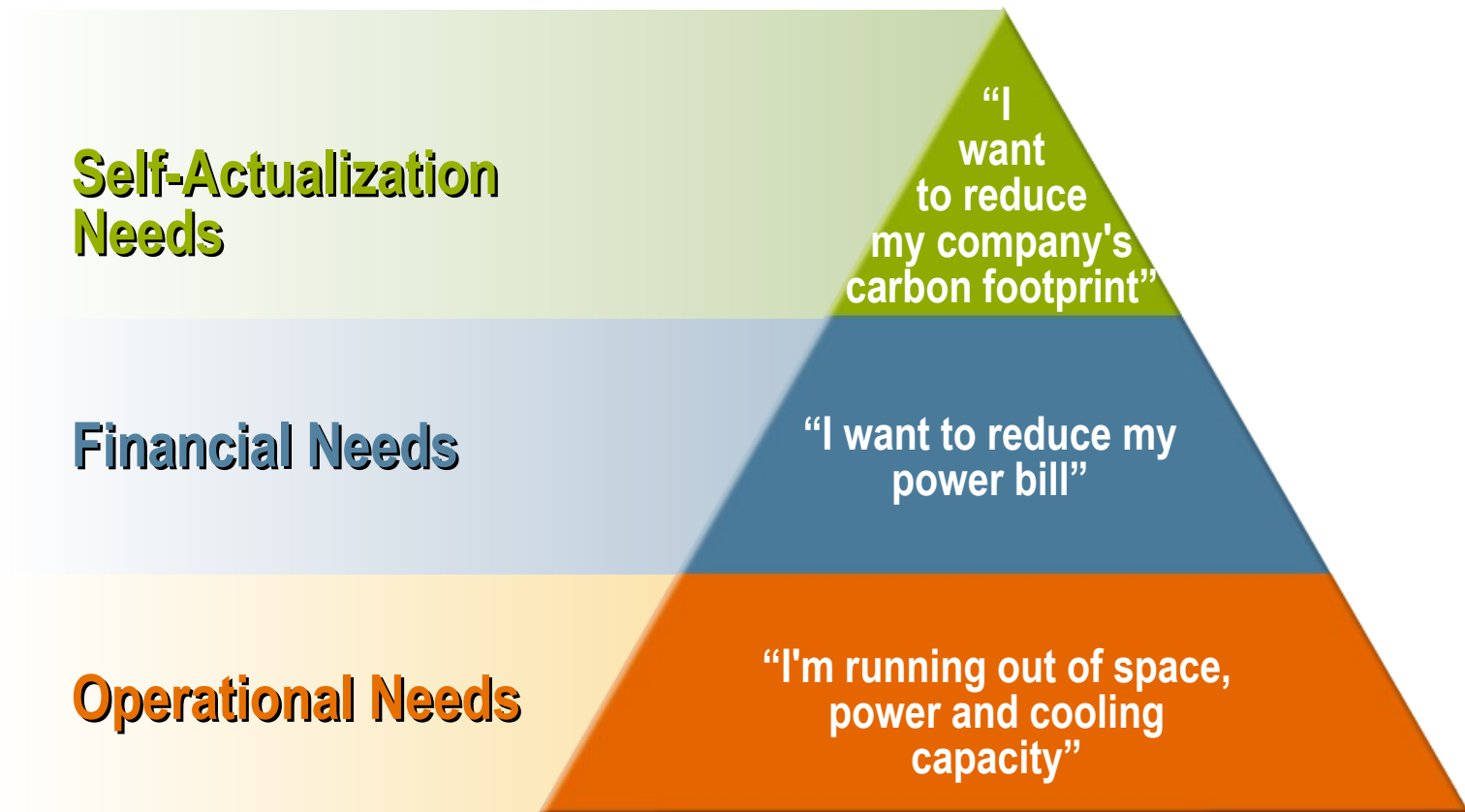
$$$

Eco – It's About Economics, Ecology AND the Ecosystem

Is Computing Sustainable?

Three reasons to say "No" today
> Energy and natural resources to make the products
> Electricity to run them
> Energy and waste during recycle and disposal

Some Frightening Statistics

- US DC's server count grew from 5.6M -> 10.3M from 2000-2005, expected to reach 41M by 2010 (a 700% increase in just 15 years)

- Edge-compute devices are expected to grow at 5-10x PCs through 2009

- Today's average server requires 4x the power 10 years ago

- Power consumption/costs in DC's doubled from 2000-2005

- ~30% of IT operating budgets are applied to electrical costs.

- 80% of Global DCs are constrained in the areas of power, cooling and/or floorspace

- Constructing a new DC costs approx. $1000/ft^2. This equates to ~$40000 per rack, or ~$2400 for a typical server

Customer Perspectives: Maslowian Hierarchy of Data Center Operators

Self-Actualization Needs

Financial Needs

Operational Needs

"I want to reduce my company's carbon footprint"

"I want to reduce my power bill"

"I'm running out of space, power and cooling capacity"

Pragmatic Customers

Where Does the Power in a Data Center Go?

Lighting, Security, Misc., 2%

Switch Gear / Generator, 1%

PDU Losses, 5%

UPS/Transformer Losses, 12%

Servers, Storage, Switches, 33%

CRACs/Air Movement, 10%

Humidifiers, 3%

Chillers, 34%
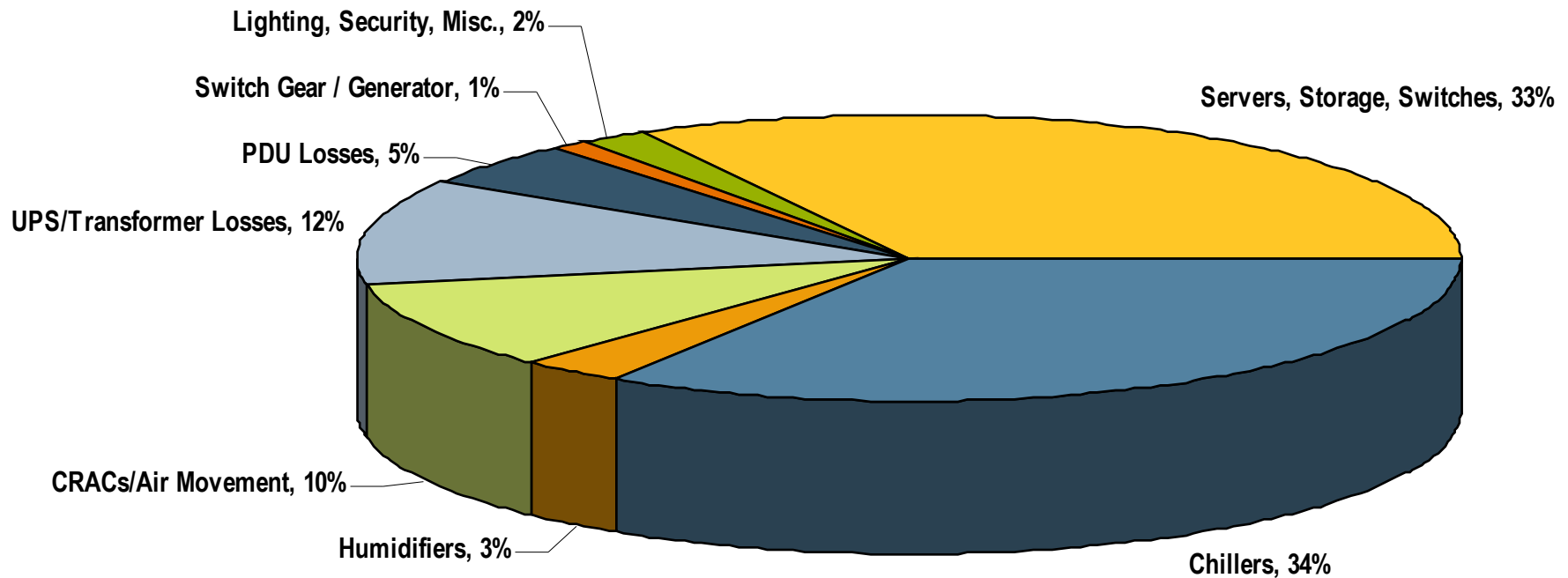
The Datacenter Power Picture

Sun's Broomfield, CO datacenter (May 2006)

	Power (kW)	Notes
Power out of Utility	1236	
Power lost in distribution	36	3% loss
Power into Sun datacenter	1200	
Power for air conditioning	209	
Power lost in distribution	277	
Power into servers, storage	714	
Power lost to server power supplies	107	15% loss
Usable DC power for servers	607	
% Usable power	**49%**	

Utilization?

Data Centers are Wasteful

1) Data Centers require huge energy – enough to power entire towns

2) 415 Billion Kilowatt Hours used by U.S.A DCs in 2006 (IDC)

3) Saving 25% of this would save @ $12 Billion p.a.

4) Worse, massive burning at source yields very little energy to the IT destination

5) Estimates of DC consumption range from 2% of all carbon to 5% of commercial energy

Cost to power 1MW input for a year	$1,400,000
Traditional 1800 server DC Power	5MWhr
Coal Used per day/ year	61 / 22k Tons
CO2 Emitted per day/ year	182 / 67k Tons
Coal to Electricity Conversion	70% Loss
Energy in DC used by Cooling/ UPS	65%
Energy Used to Power IT Equipment	35%
Storage Usage Factor	30% utilized
Server Usage Factor	15% utilized
Coal to Effective DC Energy Used	**1.5%**

Inter-site Variations

- Large variations between sites (and surveys) make it difficult to talk about a 'typical' site:
  - > LBNL found a range of 33 – 75% in total energy use by IT equipment*
  - > Average site used 57% for IT*
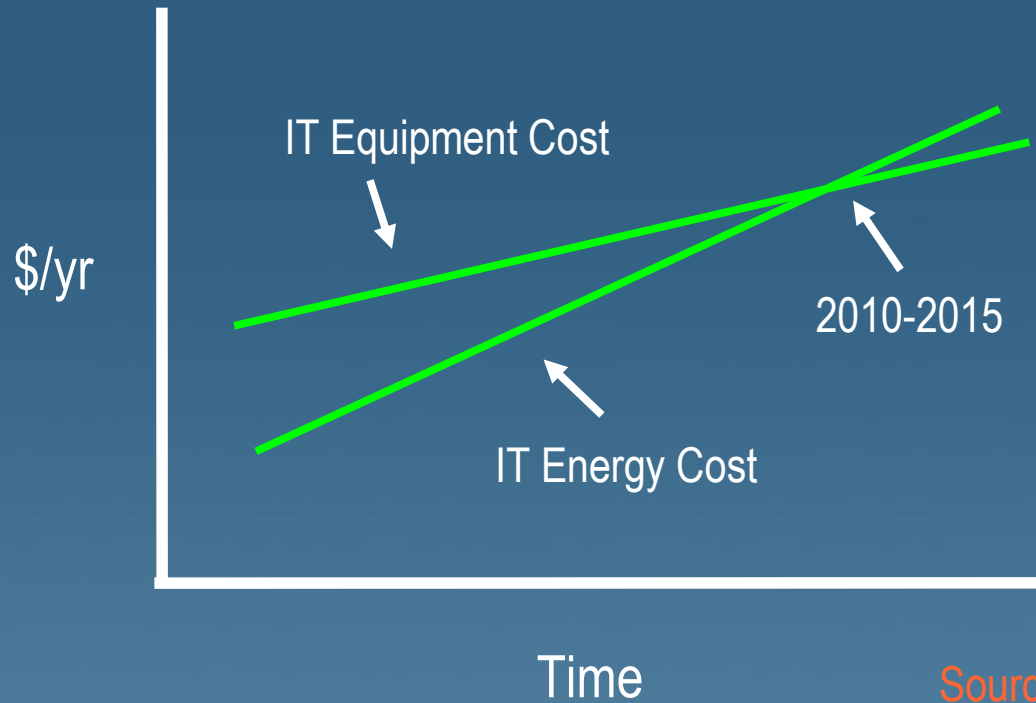 - > 33% of sites use more energy for facilities than IT*
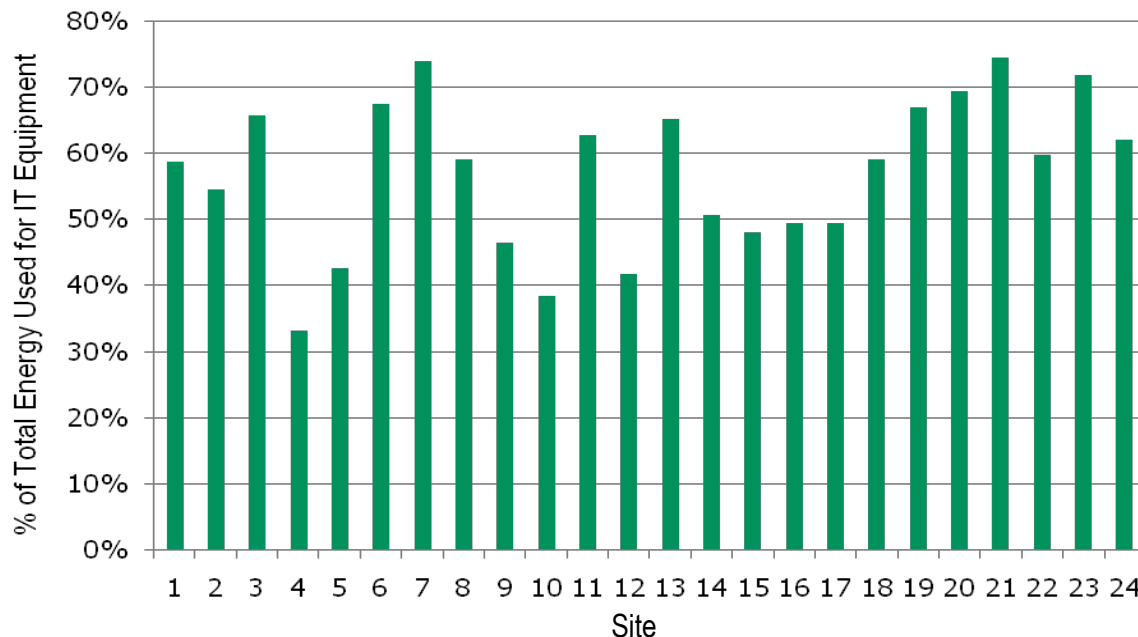
Facilities power **less** than IT power

Facilities power **more** than IT power

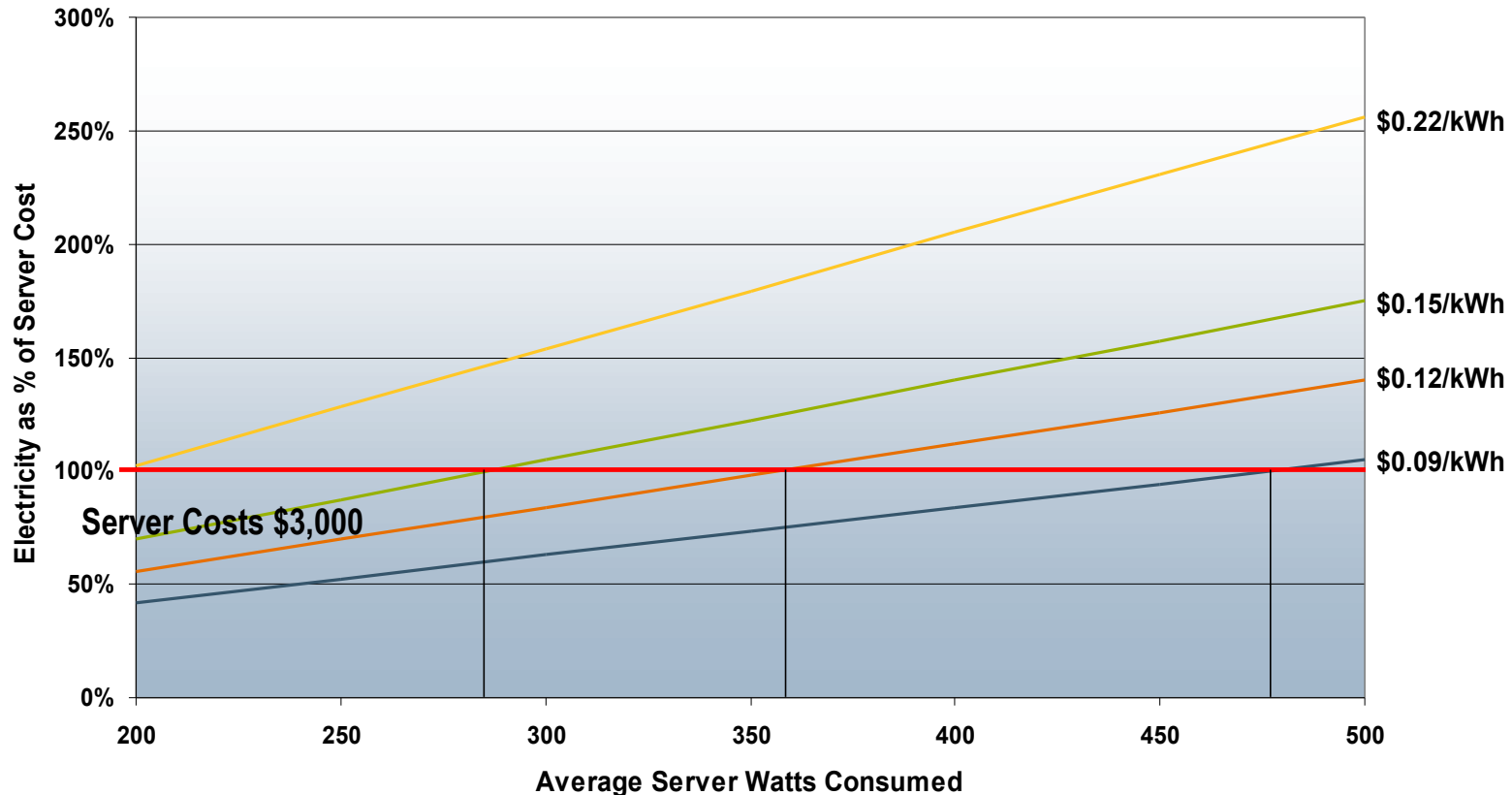*LBNL Benchmarking of 24 Data Centers

Energy Costs Rising

Increasing power density is shifting the balance of cost

When OPEX Overtakes CAPEX

Electricity OPEX as % of Server CAPEX Over Server Lifetime of 4 Years

The cost of operating a server will exceed the cost of buying it between 2010-2015 - IDC
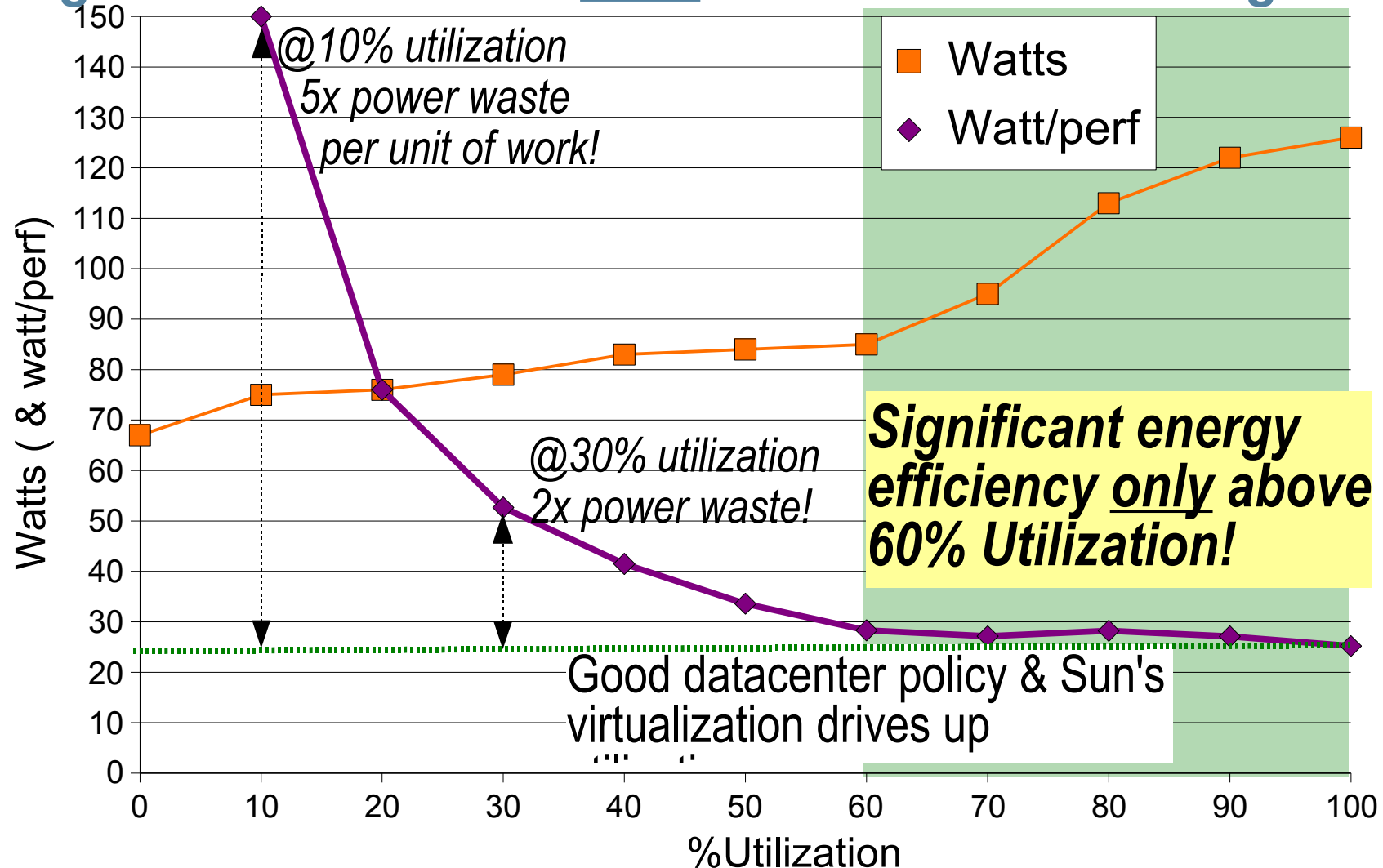
Environmental Impact

Sun Datacenter
- 2006
- 10.5M kWh
- 10K tons of CO2

WW Datacenters
- 2006
- 290B kWh
- 200M tons of CO2

Energy Waste at Low Utilization:
High %Utilization Saves More than Best Power Saving HW/SW

**@10% utilization
5x power waste
per unit of work!**

**@30% utilization
2x power waste!**

Significant energy efficiency *only* above 60% Utilization!

Good datacenter policy & Sun's virtualization drives up

Legend:
- Watts (orange square)
- Watt/perf (purple diamond)

Y-axis: Watts (& watt/perf)
X-axis: %Utilization

Sun's Eco Innovation Initiative

Eco Responsibility at Sun

| INNOVATE	ACT	SHARE
Eco Friendly Products and Services	Environmentally Conscious Operations	Applying Transparency and Open Source to Environmental Challenges

Our Strategy

1. Open, honest and transparent
2. Simplify the problem, drive economic value
3. Eco product leadership
4. It's not just servers and storage!
5. New services for the data center level
   - Air flow analysis and corrections
   - Environmental analysis and corrections
6. Be a leading example
7. Make it easy for our customers to return products for environmentally responsible lifecycle management

Sun's CSR Effort

- Sun has a history of Corporate Social Responsibility
  - > Now we're formalizing it

- Range of topics
  - > Some typical: corporate governance, diversity, supply chain
  - > Some unique: transparency, assistive technologies

- Sun's first formal CSR report out - Jan 07 (sun.com/aboutsun/csr)
  - > Regular updates throughout the year

ACTIONS SPEAK
LOUDER THAN WORDS
INNOVATE. ACT. SHARE.

SUN'S 2006 CORPORATE SOCIAL RESPONSIBILITY REPORT
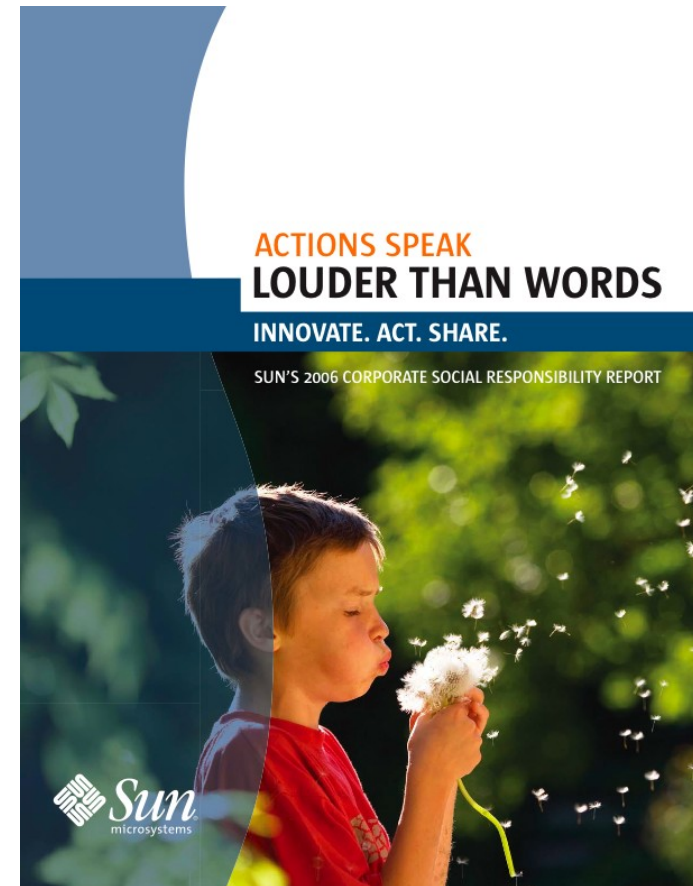
Eco is Part of Sun's CSR Effort

- Wide ranging scope
  - > Industry consortiums
    - – Green Grid
  - > Corporate Programs
    - – iWork/OpenWork
    - – Recycle/Reuse
  - > Product Innovations
    - – Lower Energy, Higher performance
    - – Broad technology use for Eco-benefit
  - > Customer shared
    - – Best Practices, Lessons Learned
    - – Tools, IP

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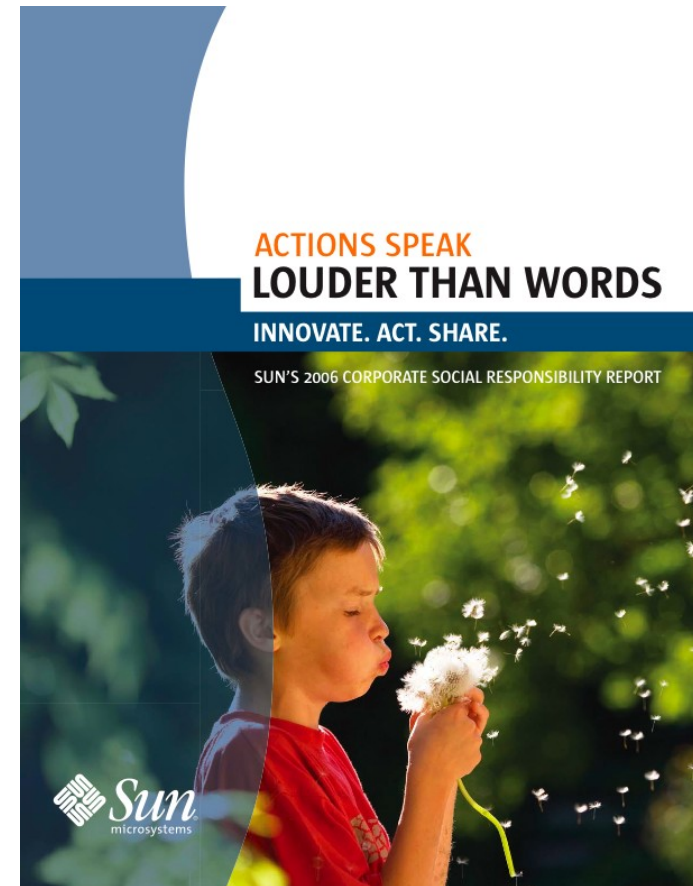
The Green Grid

- A global consortium dedicated to developing and promoting energy efficiency for data centers by:

- Defining meaningful, user-centric <u>models and metrics</u>

- Developing <u>standards</u>, <u>measurement methods</u>, <u>best practices</u> and <u>technologies</u> to improve performance against the defined metrics

- Promoting the <u>adoption of energy efficient standards</u>, processes, measurements and technologies

- A consortium bringing together industry leaders and end users from critical segments of the data center ecosystem to develop a unified voice around data center efficiency issues

- Memorandum of Understanding (MOU) signing with the <u>Department of Energy (DOE)</u>

Corporate Programs - Sun's Open Work Program for Employees

> A Global, Location-Independent Program Providing Technologies, Workspaces, and Best Practices

> 2005 EPA Award: 4th in Nation for Commuter Friendliness

PARTICIPATION

Flex Location Workers
Over 17,000 participants
Over 55% of Work Force

Flexible Offices
127 Locations Worldwide

BENEFITS

Real Estate
6,600 Seats Saved/Avoided
in FY06 = $63.9M

Sun Ray - thin clients
Over $24M Saved Annually
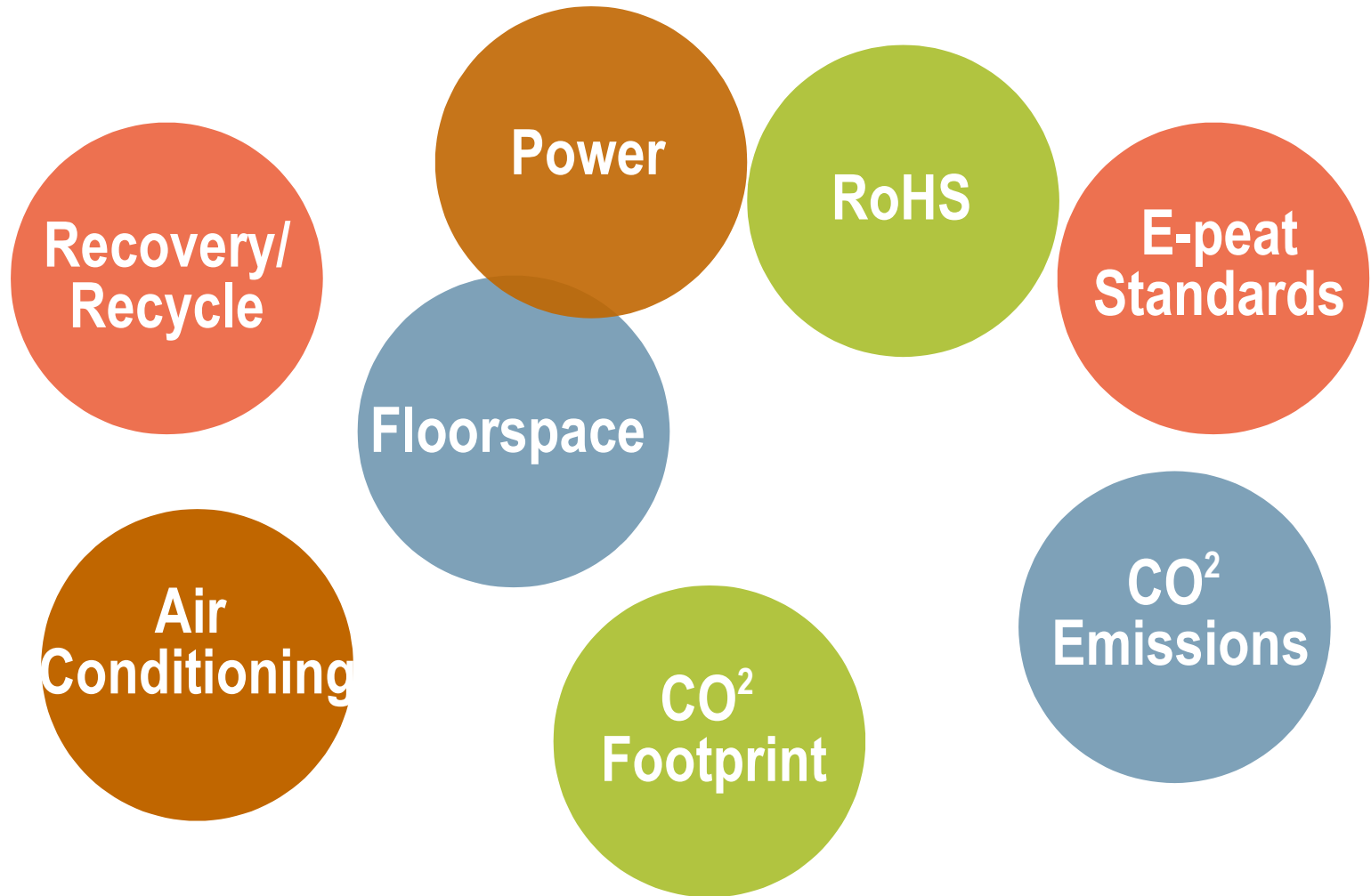No-Cost Moves & Energy Savings

Carbon Reduction
30,000 tons/year and growing

Green Datacenters

- Leading by example
- System upgrades and consolidation
  - > 60%+ reduction in ft^2
  - > 60%+ reduction in utility $
- Advanced cooling
- Eco-conscious site selection
- Green energy options
  - > Primary power
  - > Backup generation

Eco-concerns in Product Dev.

Power

RoHS

Recovery/ Recycle

E-peat Standards

Floorspace

Air Conditioning

CO^2 Footprint

CO^2 Emissions

Federal EPEAT Program

- Electronic Product Environmental Assessment Tool (EPEAT) is a system designed to assist purchasers in the public and private sectors in evaluating, comparing and selecting desktop computers, notebooks and monitors based on their environmental attributes.

- EPEAT also provides a clear and consistent set of performance criteria for the design of products, and provides an opportunity for manufacturers to secure market recognition for efforts to reduce the environmental impact of its products.

- On January 24, 2007 President Bush signed Executive Order 13423 mandating federal agencies to buy EPEAT registered products. The Executive Order also includes other green purchasing and environmental improvement requirements.

It Starts with Innovation

Product Life Cycle Management - eWaste and HazMat Leadership

- Design for disassembly, reuse and recycling

- Global takeback program
  - > Free return of products anywhere in the world
  - > Over 50% is reused
  - > All metal and plastic recycled
  - > Less than 5% enters waste stream

- WEEE and RoHS compliant

European WEEE Directive sets target that 65% of IT equipment must be recycled*
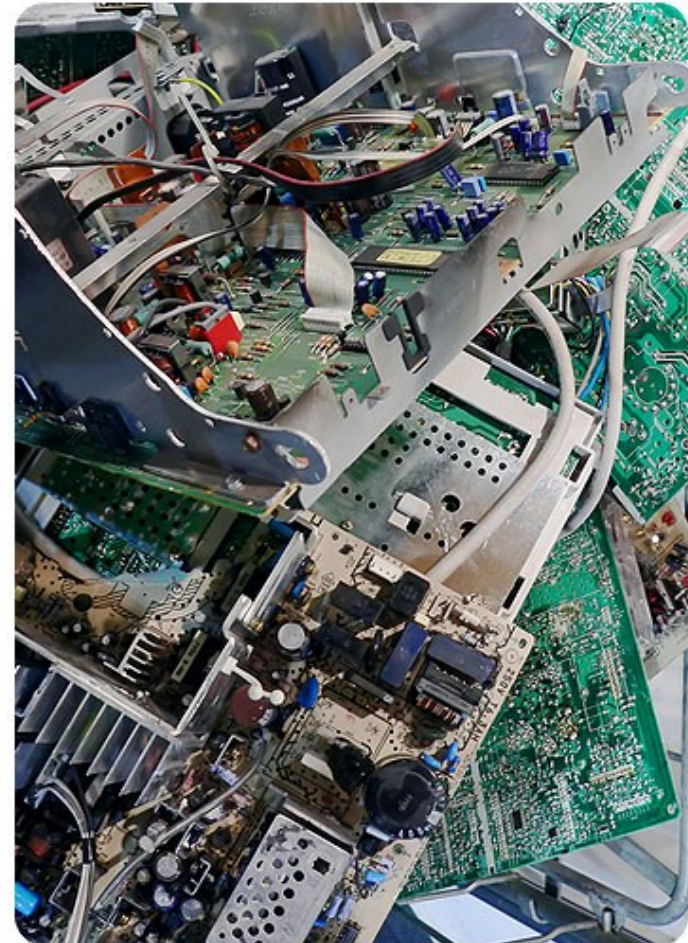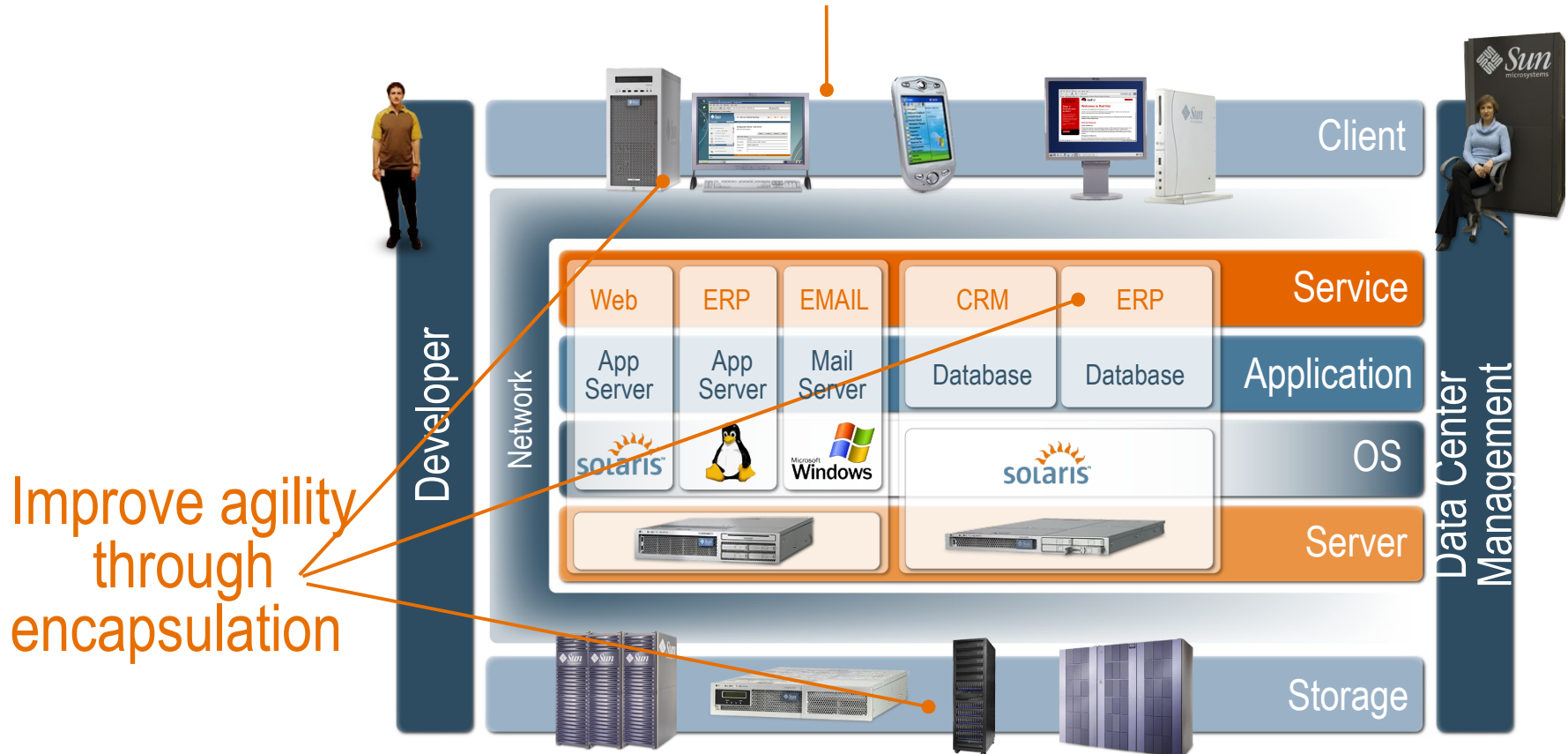
Optimization Drivers Change....

- ## Early 2000 - Reduce cost
  - > Excess capacity from Dot-com bust
  - > Changing business models

- ## 2003-05 – Business agility
  - > Improve business metrics (-ilities)
  - > Continue to manage costs

- ## 2006-present
  - > Eco-concerns come front and center
  - > Manageability a concern
  - > Data center facilities are tactical issues

- ## Future - Deliver business value
  - > Within context of eco-concerns and regulations
  - > RoA, costs management
  - > Business enabler
  - > Disaster recovery

The Vision: *Virtualize Everywhere*

Maximize system resources across entire Datacenter

Improve agility through encapsulation

Client					
Service	Web	ERP	EMAIL	CRM	ERP
Application	App Server	App Server	Mail Server	Database	Database
OS	solaris	(Linux)	Microsoft Windows	solaris	
Server					
Storage					

Developer

Network

Data Center Management

The Opportunity

Increase Utilization Levels to as High as 85%

Improve Space Efficiency by 2x

Cut Energy Costs in Half
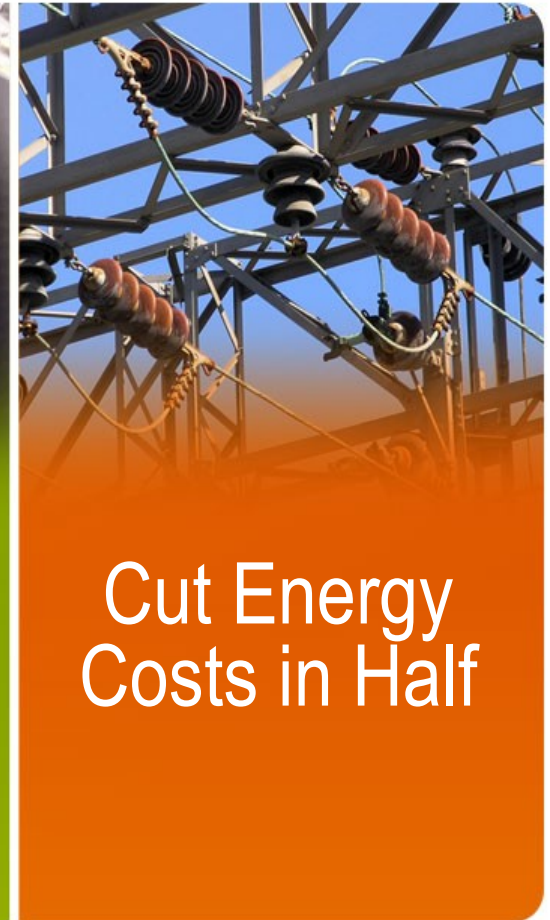
Elements of Datacenter Optimization

Optimization Roadmap ➜ **Tomorrow's Optimized DC**

Business Value

Migration
Consolidation
Standardization
Virtualization
Grid Engines
Automation/ Provisioning
SOA (-ilities)
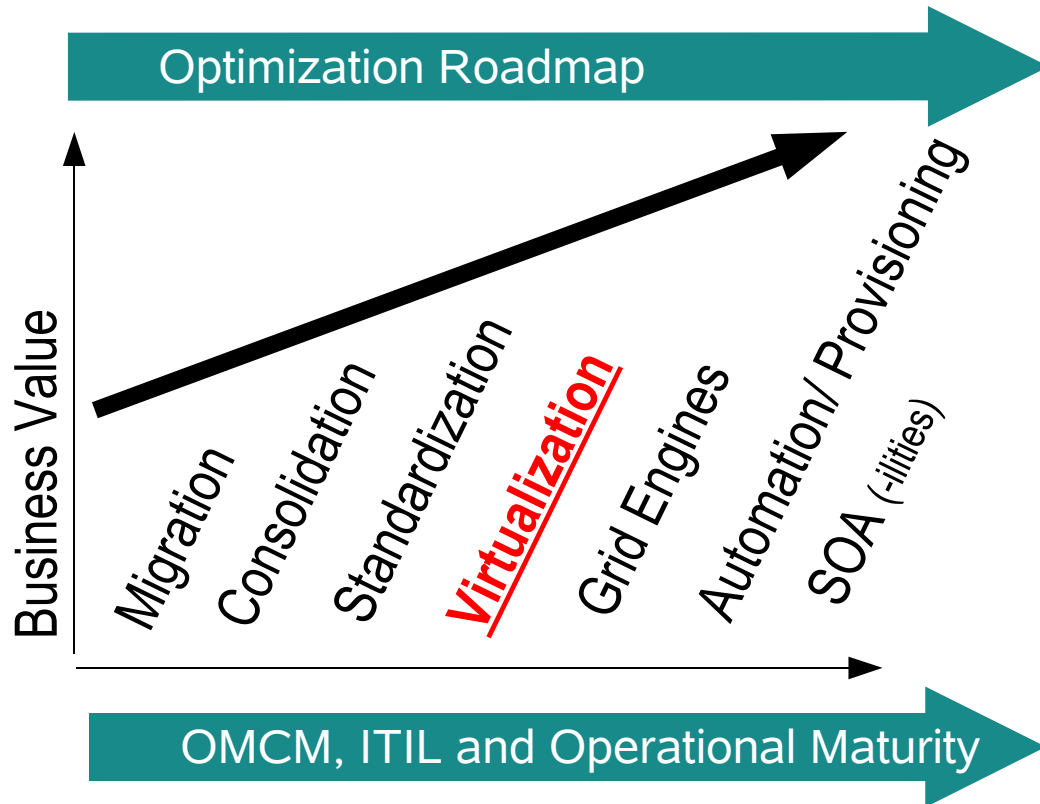
Higher Business Value
Improved Business Servicing
Architectural Simplicity
Lower costs & facility req.
Better Manageability
High Service predictability
Utility-type
Provisionable
Highly Optimized
Highly utilized
Highly Virtualized

OMCM, ITIL and Operational Maturity ➜

Address Key Portions or All of the Architecture

Systems	Resource Mgmt	Applications	Storage	Network
solaris / Linux / solaris / Windows **HYPERVISOR**	OS	solaris solaris solaris	solaris	solaris / Linux / Windows **HYPERVISOR**
LDOMS	Server			
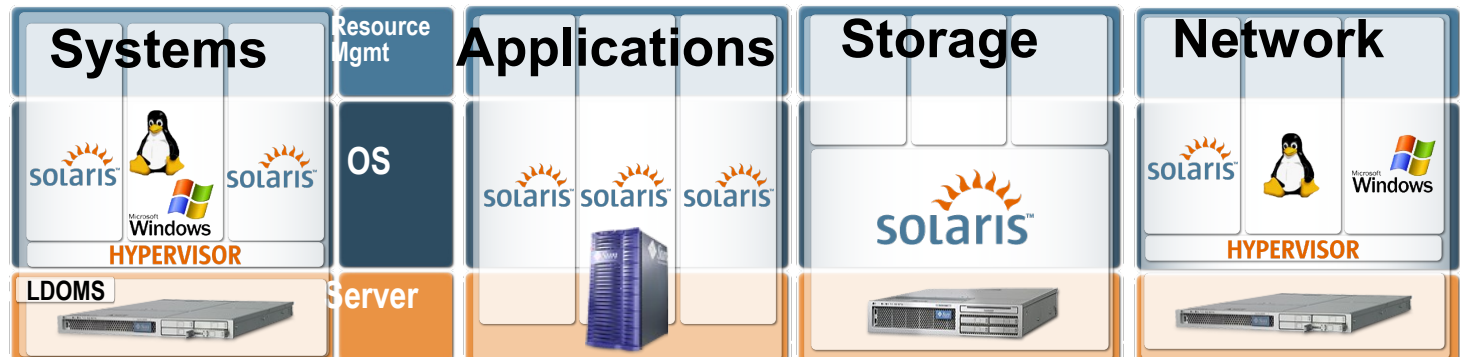
Huge Opportunities for Virtualization Across the Infrastructure

Network
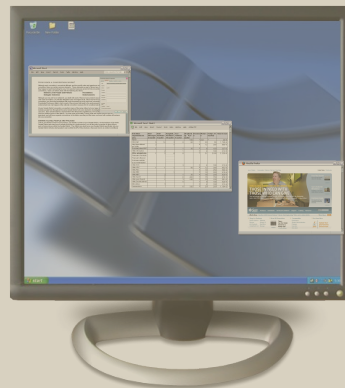
Application/Server

Storage

Innovate: Sun Eco Solutions
Beyond the Box

Desktop

Sun Ray 2

Datacenter

Sun Fire x4600

Sun Fire x4500

Sun Fire T1000/2000

SunBlade 6000

Sun Fire x64

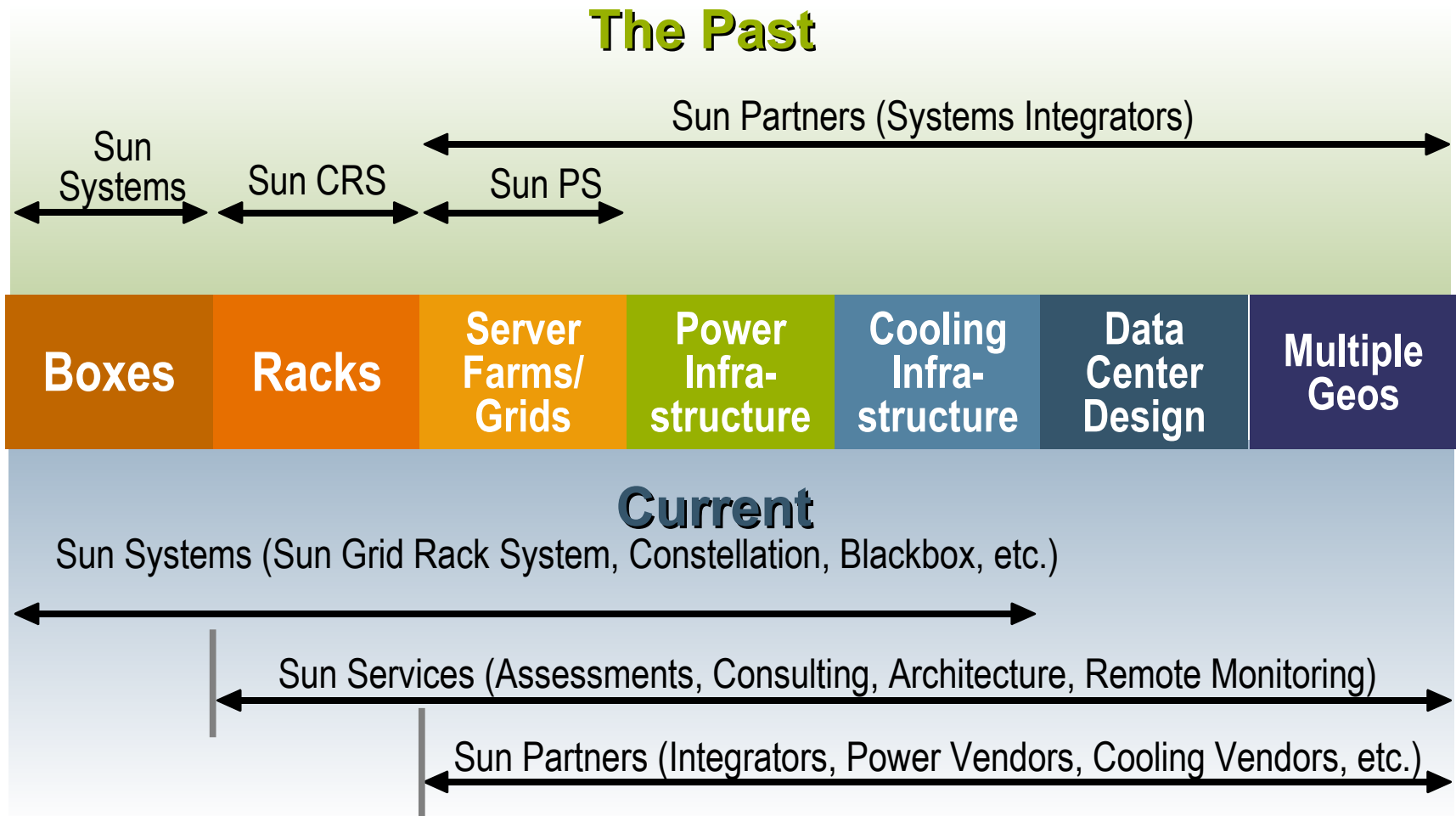### Data Archive

Sun StorageTek 6540 Disk array

Sun StorageTek SL8500 Tape Library

Virtualization

solaris

Microsoft Windows

The Data Center Value Spectrum

The Past

Sun Partners (Systems Integrators)

Sun Systems

Sun CRS

Sun PS

Boxes	Racks	Server Farms/ Grids	Power Infra- structure	Cooling Infra- structure	Data Center Design	Multiple Geos

Current

Sun Systems (Sun Grid Rack System, Constellation, Blackbox, etc.)

Sun Services (Assessments, Consulting, Architecture, Remote Monitoring)

Sun Partners (Integrators, Power Vendors, Cooling Vendors, etc.)

Eco Product Leadership

Sun Fire T1000

CMT

- 2X the performance
- 1/3 the power consumption
- 1/2 the space
- Qualifies for PG&E energy rebate program

The Power of 32 Servers
9600watts

Replaced with 7 servers using 1900 watts

SunRay Thin Clients

- Desktop runs on shared server
  - > Gets PC out of the office
  - > 10:1 – 50:1 SunRay to server ratio
  - > No client upgrades!
- Operational carbon savings
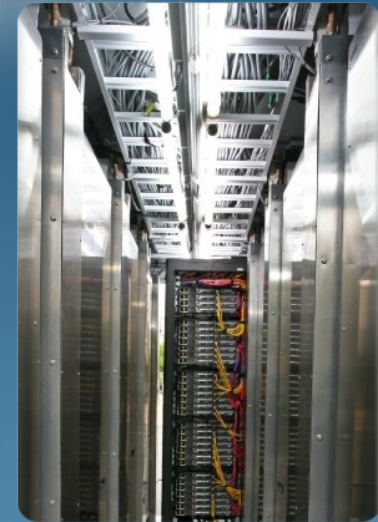- Potential for huge carbon savings by avoiding the PC upgrade cycle and associated manufacturing impact

SunRay 2

- **4 watts**
- **Windows, Linux or Solaris desktop**
- **Standard monitor, keyboard, mouse**

Project Blackbox
World's First Virtualized Datacenter
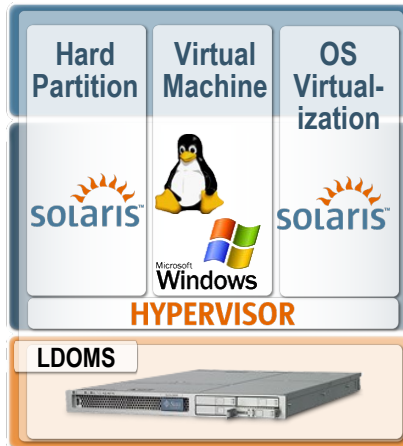
- 40% lower cooling cost
- 1/4 the space
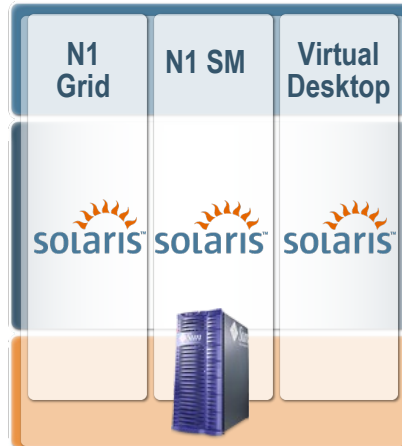
Look Left, Look Right

- Server consolidation adoption estimated at ~90%
- Virtualization adoption at ~40%, but growing rapidly
- Blade technology is re-emerging as one of several DC infrastructure building blocks
- Only ~30% of DCs have consolidated storage/data
- Virtual Desktop Infrastructure (VDI) is emerging, expected to grow even faster
- IT $ will shift to virtual infrastructure management software/frameworks as price drops on engines/technology
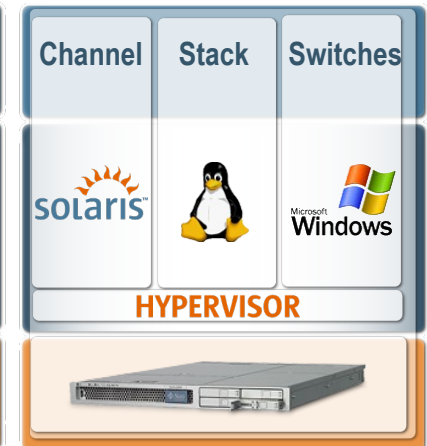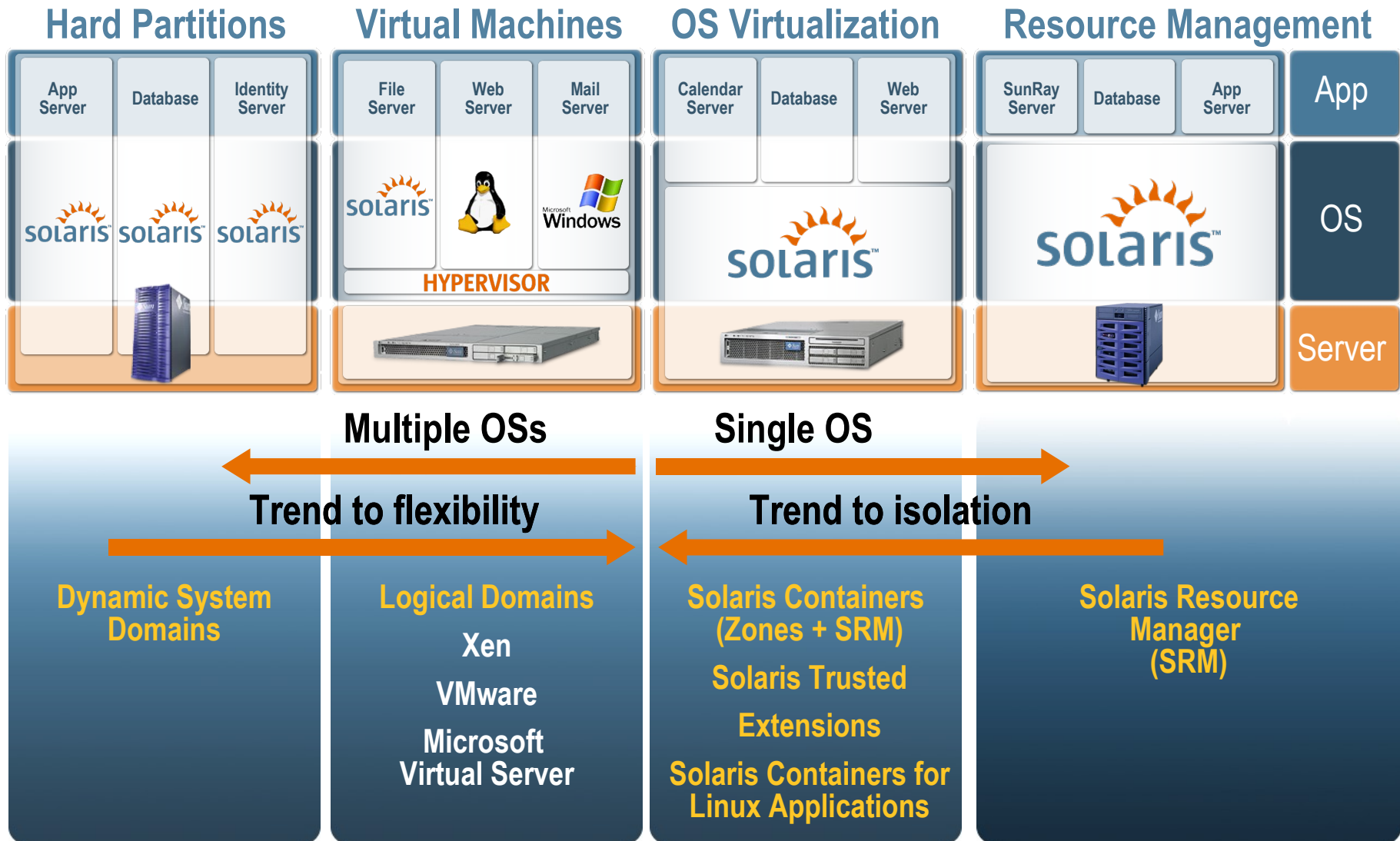
Sun's Virtualization Technologies

Systems

Hard Partition	Virtual Machine	OS Virtual-ization
solaris	🐧 Linux / Microsoft Windows	solaris
HYPERVISOR		

LDOMS

Resource Mgmt
OS
Server

Applications

N1 Grid	N1 SM	Virtual Desktop
solaris	solaris	solaris

Storage

Device Level	Network Level	Server /OS Level
solaris		

Network

Channel	Stack	Switches
solaris	🐧 Linux	Microsoft Windows
HYPERVISOR		

Broad Spectrum of Technologies and Solutions across the Infrastructure

Storage Virtualization Spectrum

Device			Network			Server/OS		
Disk Array	Tape	VSM/ VTL	SAN	NAS	Other	VM	FS	NIC

VM

solaris™

Toward storage device ··· **Toward application**

ST9900	INSP	ZFS
VTL	Cisco	SAMFS
VSM	Brocade	SVM
		VVM
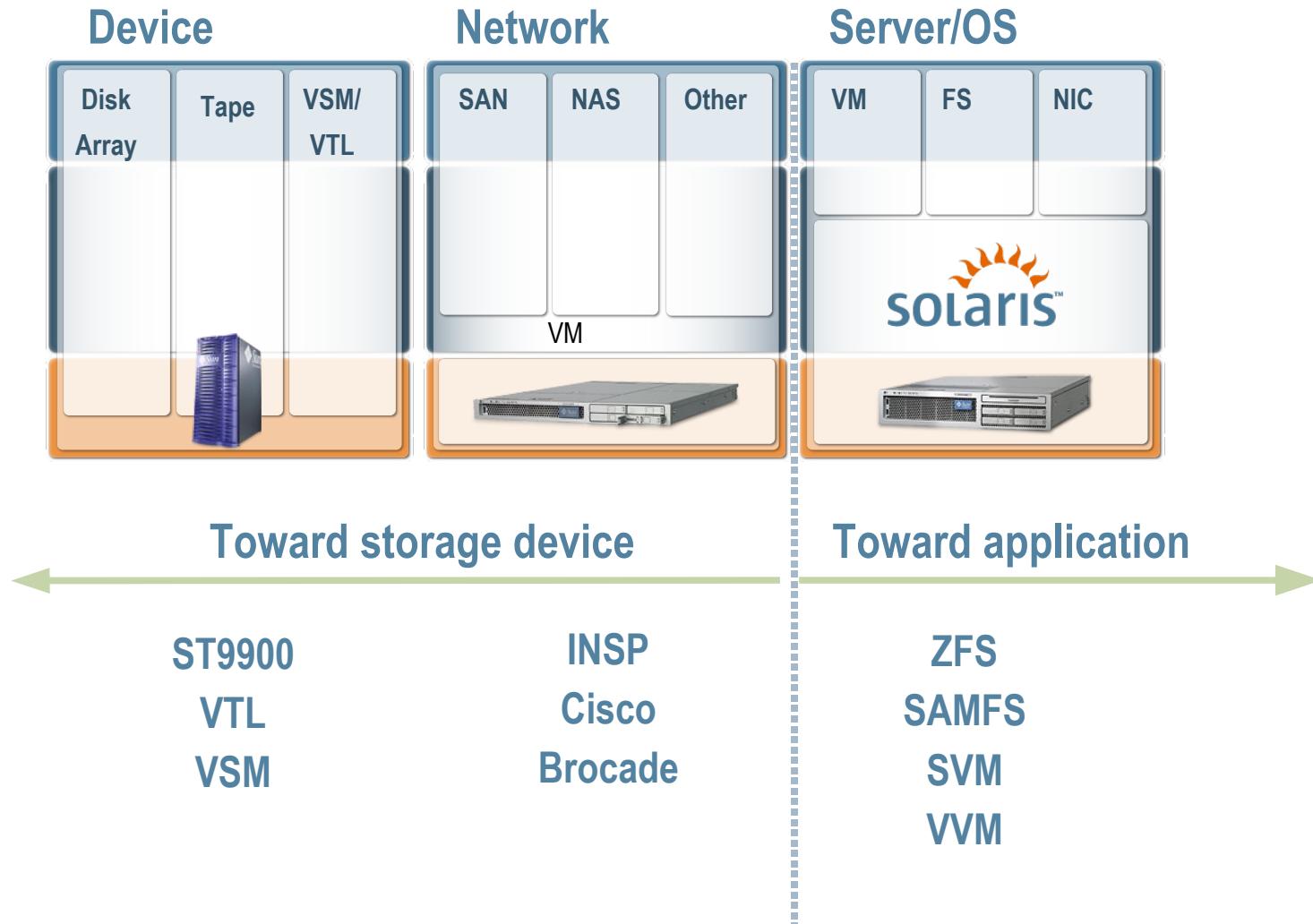
Tiered Storage Architecture

Sun StorageTek SL8500 Tape Library

- Older data is less valuable; use ILM to manage

- SL8500 40% increase in power efficiency

- 25–50% less space than comparable libraries

- 10x less energy than comparable disk array

- 2x drive capacity and performance with T10000 tape drive

Sun Virtual Display Computing Offerings

Data Center

Sun™ Secure Global Desktop Software

Sun Ray™ Software

Enhance existing devices by providing secure access to applications of any type

Deploy virtual display clients for end-users that don't require a PC

Sun Ray Clients

Virtual Desktop Solution
## Sun Ray and Secure Global Desktop

NEW!

- Desktop runs on shared server
  - > Uses less than1/10th the energy as a typical PC
  - > Accesses Solaris, Linux, Windows, mainframes and AS/400 apps
  - > 10:1 – 50:1 Sun Ray to server ratio
  - > No client upgrades required!
- Virtual desktops enabled dynamically
- Customers avoid $millions in energy and systems costs annually

Sun Ray 2

- 4 watts
- Windows, Linux or Solaris desktop
- Standard monitor, keyboard, mouse

Top 10 Consolidation Best Practices
It's Not Just the Technology...

1. Get executive-level support
2. Agree on business goals
3. Pro-actively address company politics
4. Establish service level agreements with customers
5. Standardize where possible
6. Consolidate storage first where possible
7. Perform extensive planning and documentation
8. Train IT staff on how to manage the consolidated environment
9. Develop new applications for consolidated environment
10. Get help from Partners with experience
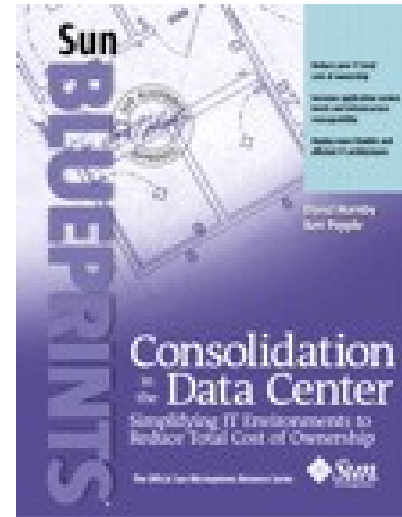
Sun Eco Leadership

UltraSPARC® T1 Processor with CoolThreads™ Technology	SunFire™/ Sun SPARC® Enterprise T1000/T2000 Systems
11/2005	12/2005

PG&E Rebate	2006 and 2007 Sun Named to List of 100 Best Corporate Citizens	Sun Named "Greenest Company Under the Sun" by Fortune Editor David Kirkpatrick	Open Work and the CoolThreads Servers Each Won Flex Your Power Awards	UltraSPARC T2 Processor
8/15/2006	2006-2007	4/2007	5/7/2007	8/2007

100 Best Corporate Citizens

FORTUNE

Sun European Datacenter Consolidation

Result: Sun Achieved Over 70% Utility Reduction and 80% Space Compression by Consolidating European Datacenters

- 80% reduction in footprint

- Over 70% reduction in energy costs (>$115K/year)

- Refreshed 22 servers with
  4 Sun high-efficiency models

- Optimized power from 2kW to 9kW per cabinet

- Enhanced storage utilization and management

- Improved performance and availability

Sun Bay Area Datacenter Consolidation
Result: Sun Achieved 60% Reduction in Utility Costs

- Phase 1: Hardware Consolidation
  - Over 450% increase in compute power with ~1/2 the servers
  - Over 240% increase in storage capacity with ~1/3 the storage devices
  - Over 60% reduction in energy costs ($860,000 savings in 9 months)
  - Compressed datacenter space by 88%
  - Reduced carbon emissions by 3,227 metric tons annually

- Phase 2: Move into Energy Efficient Datacenter
  - Awarded nearly $1 million rebates and awards
  - Expect additional 30% KWh/mo and 32% utility cost savings
  - Reduce carbon emissions by an additional 876 metric tons annually

Eco = Ecology + Economics

| Sun Innovation	CO2 (tons)	Financial ($)
OpenWork	~30,000	60 Million
Broomfield, CO datacenter	~630	100 Thousand
SunFire T1000/T2000 (Niagara)	~225,000	Over 300 Million
Eco Impact	**Sun saves over 250,000 tons of CO2**	**Sun grows top line, drives out costs**

Share with Customers

Sun's Eco Tools

Learn How to Fish...

- Sun℠ Eco Services Suite
  - > Assessment – Basic and Advanced
  - > Cooling Efficiency
  - > Optimization
- Sun Blade 6000 Power Calculator
- Energy Efficient Sun Reference Architecture
- Eco Datacenter Reference Guide
- Sun Blueprints
- Eco Resource Center on sun.com
- Eco Efficiency Whitepapers
- Eco Solution Center Case Study
- Free Eco Virtualization Workshop

NEW!
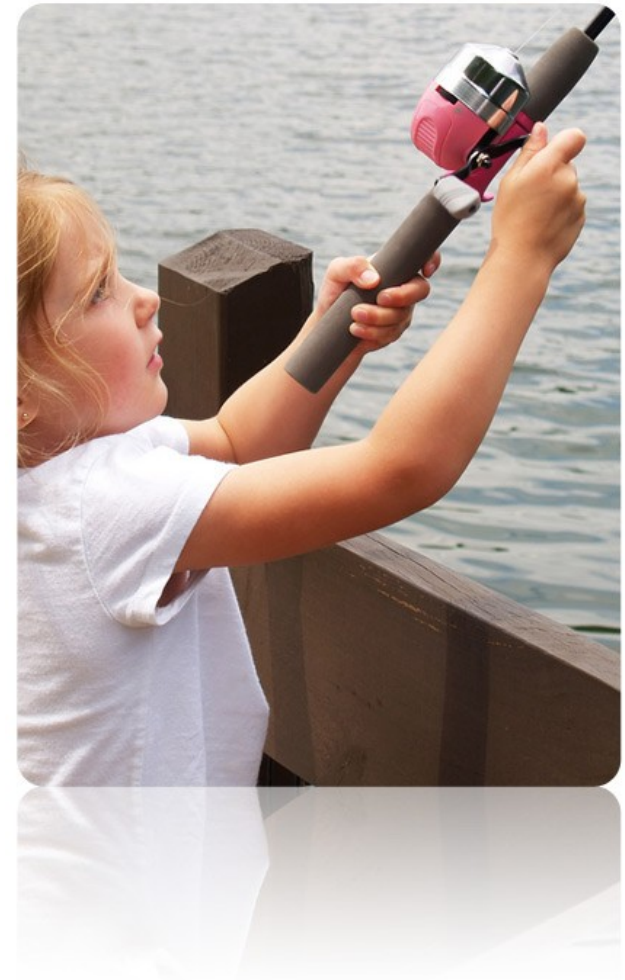
Share Best Practices - Short Term Data Center Solutions

- Eliminate Unused Systems

- Organizational Changes
  - > Let the decision makers share in the savings

- Reduce Computer Equipment Consumption

Eliminate Unused Systems

Example: Eliminating Unused Systems

- Studies at Sun and another major computer manufacturer
- Aged servers with no use still in data centers
- 8%-10% of servers studied had no identifiable function
  - 150 of 1800 in one study
  - 354 of 3500 in another study
- At Sun, systems were turned off, kept in place 90 days
- If no complaints after crossing quarter boundary, removed

> 8%-10% of IT equipment load
> 11%-14% of total load
> 90 days or less to implement

Let the Decision Makers Share the Savings

- Many organizations disconnect electric consumption from energy budget
  - CIO one of largest consumers of energy
  - VP of Facilities pays bill

- Align spending with budget responsibility
  - Give CIO electrical budget
  - Give Facilities IT capital budget
  - Allow for savings to get accounted for where they happen

Reduce Computer Consumption

- ## Benefits of reducing system consumption
  - ### 2:1 (or more) payoff
  - ### Each watt saved on IT floor = 2 watts or more not drawn from utility
  - ### No need to condition, distribute, cool unused watts

- ## Strategies
  - ### Buy smarter
  - ### Technology Refresh
  - ### Consolidation and virtualization

# Best Practices: DC Eco-Optimization

Implement an Energy Plan

- Improve Solution Design
- Optimize System Utilization
- Enable Power Management
- Retire Unused Systems
- Use Power Efficient Systems
- Accelerate Technology Refreshes
- Improve Storage Efficiency
- Improve Cooling Efficiency
- Improve Power Distribution Efficiency
- Match Infrastructure to SLAs

Guiding Principles to Eco-Optimization

- Create a Datacenter Optimization roadmap that employs/plans for current and emerging technologies

- Workshop with stakeholders to understand business drivers

- Weigh risk/reward benefits fully in establishing feasibility of effort

- Create reference architectures to drive standardization practices

- Leverage virtualization technologies to drive high asset utilization

- Architect to optimize costs savings against other business drivers

- Incorporate compliance regulations/requirements, controls, business continuity concerns in consolidation planning

- Incorporate IT service management philosophies and tools for managing risk and improving flexibility

Sun's Simple 3 Step Approach to Improve Efficiency
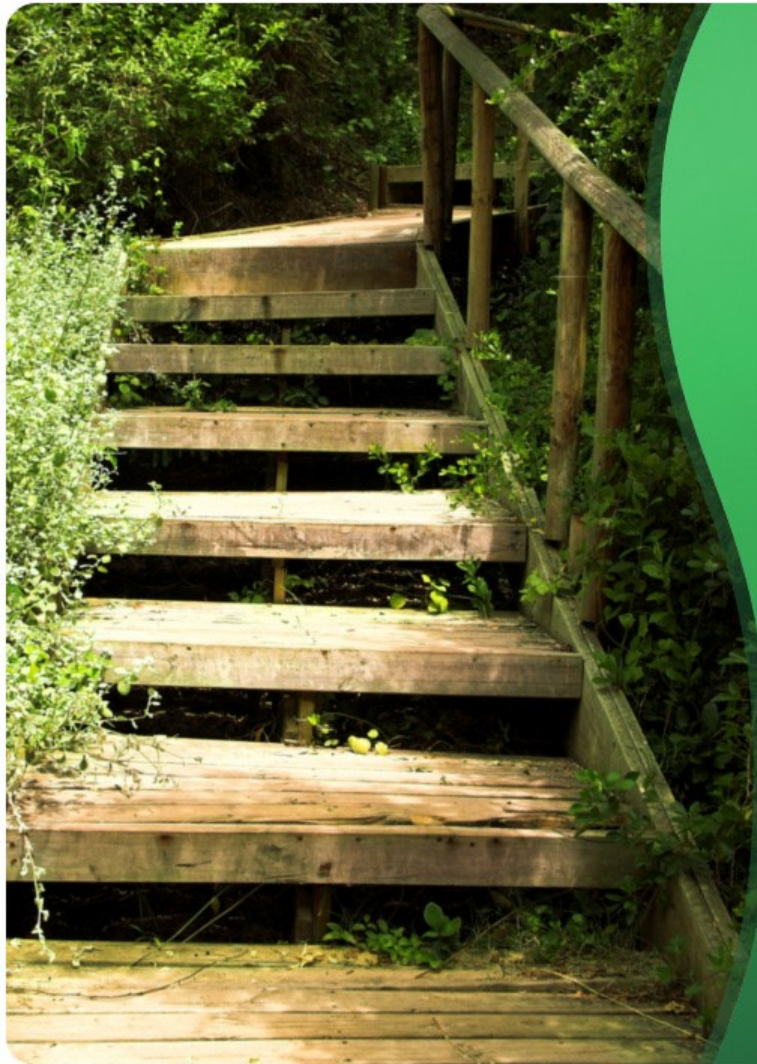
1. Assess

Measure the current state of your datacenter and recommend ways to optimize space, power and cooling for better efficiency, utilization and ROI

2. Optimize

Upgrade to energy efficient Sun systems for improved performance, efficiencies and better datacenter economics

3. Virtualize

Expanded end to end approach to with new levels of Eco efficiency – both economic and ecological

Sun Eco Services Suite

Optimize your power usage and IT budget

A complete portfolio of Eco-related services

Designed to establish a baseline for existing conditions,

Identifies areas of improvement

Provide plans for optimizing energy usage, cooling, and general environmental conditions.

- The offerings include:
    - > Sun Eco Assessment Service for Datacenter (Basic or Advanced)
    - > Sun Eco Cooling Efficiency Service for Datacenter
    - > Sun Eco Optimization Service for Datacenter

Sun's Eco-Innovation Initiative – Leading by Example, Sharing with Customers

- Greening of the Datacenter - through Eco-Products, Eco-expertise, and an Eco-community

- Actionable methodology – assess, optimize, virtualize

- Leverages Systems, Software, Storage and Services

- Whitepapers, Reference Architectures, Blueprint guides, Tools (power calculators, etc)

Thank You!

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