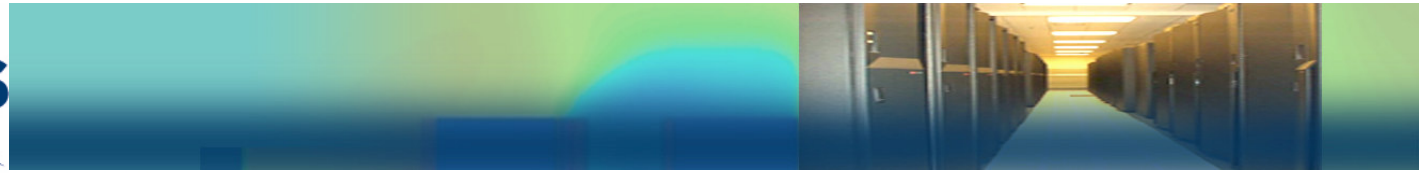
City of Fort Collins

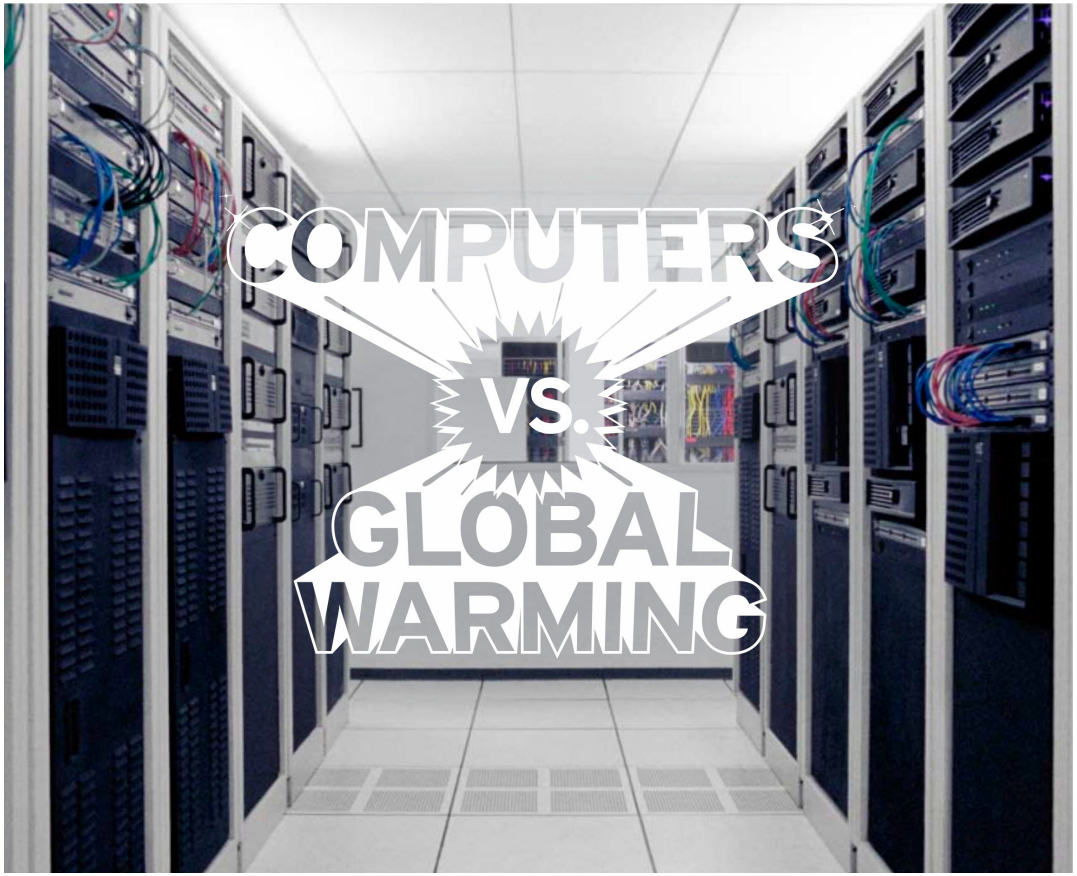


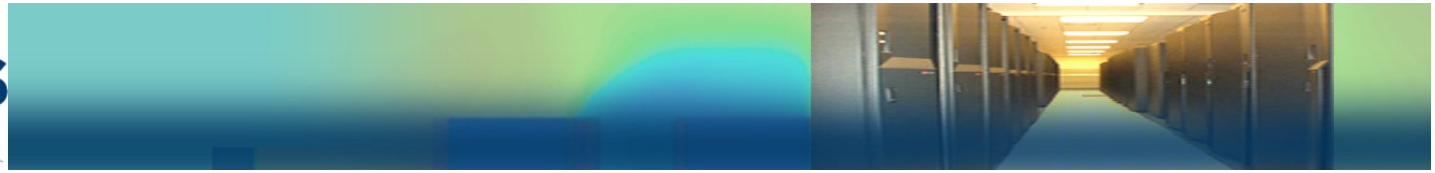
Green Information Technology

November 5, 2008

Climate Wise Fall Fair

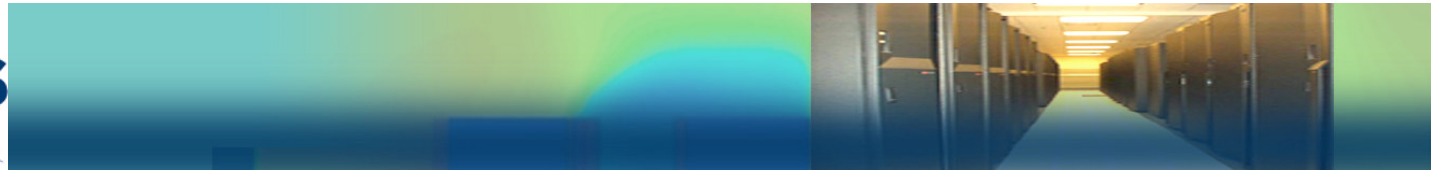
Consolidation So Promising…





Introduction

- What's your IT footprint?
  - Desktop computers
  - Servers
  - Data centers
    - Server closet < 200 sf
    - Server room <500 sf
    - Localized data center <1,000 sf
    - Mid-tier data center <5,000 sf
    - Enterprise class data center 5000+ sf
  - Chilled water systems

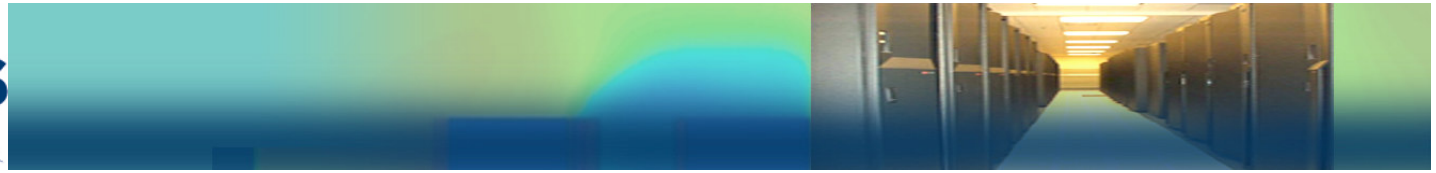


Agenda – Business Environmental Program Series

- Introduction >> John Phelan PE, Fort Collins Utilities
  - Trends in energy and IT
  - Where are the opportunities?
    - Desktops and data centers
    - Systems thinking
      - Hardware, software, operation, purchasing, disposal
- Server Virtualization >> Daniel Mudimbe, VM-Ware

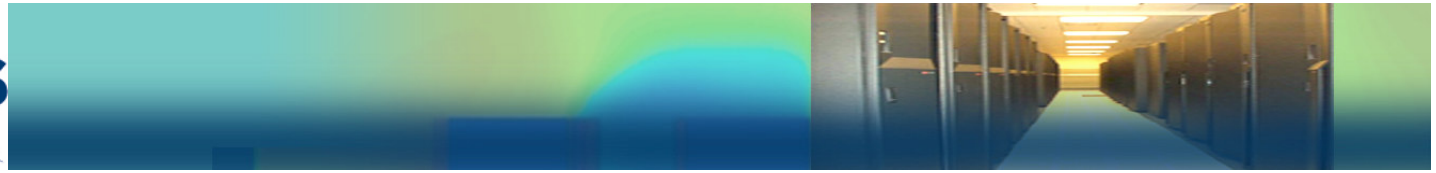
  Break
- Efficient data center cooling >> John Phelan
- Case studies
  - Data center airflow and cooling optimization >> Tom Iwanski, Platte River Power Authority
  - Data center virtualization project >> Tom Vosburg, City of Fort Collins
- Future view – What's next >> Daniel Mudimbe, VM-Ware

Presentations available at: fcgov.com/business-ep



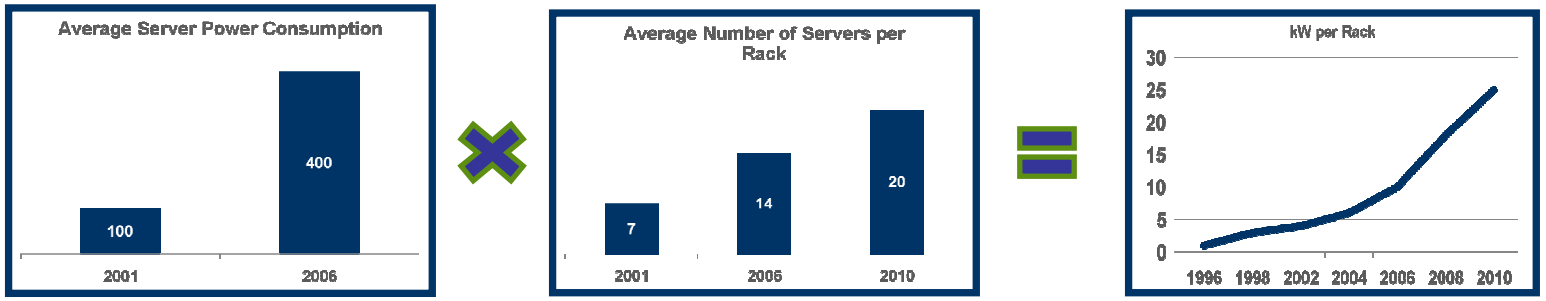
Industry trends

- Intense growth rates
  - IT workload growth is multiples of GDP for most companies, 10x for some sectors (financial services, web businesses)
  - All companies facing huge growth rates in data storage (50 to 100% annual growth not uncommon)
  - Worldwide server shipments have continued to grow despite worsening economic conditions, according to the latest figures from research firm Gartner
- Data center major trends (October 2008)
  - Blade servers: blades will account for 29% of server sales by 2012
  - Going Green: going green is less about being environmentally conscious and more about saving money
  - Virtualization: by 2011 more than half of customers' workloads will be deployed in virtual machines
  - Cloud Computing: data is growing at an exponential rate thanks to cloud computing
- The PC market is changing from “one PC per household to one PC per person”

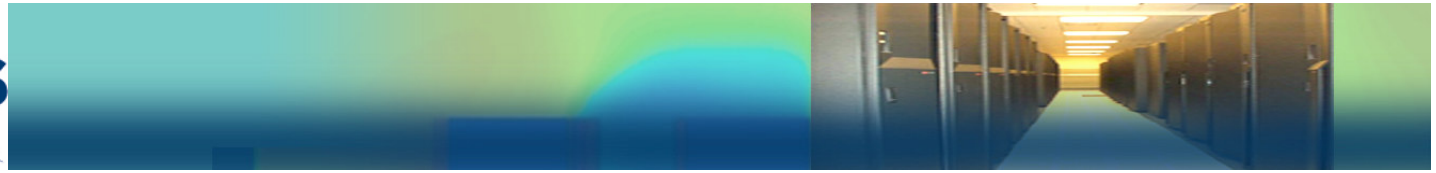


Why should utilities care?

- "A recent study by McKinsey & Co. predicted that data centers will surpass the airline industry as the largest source of carbon dioxide emissions by 2020 and called for data centers to double their energy efficiency by 2012."



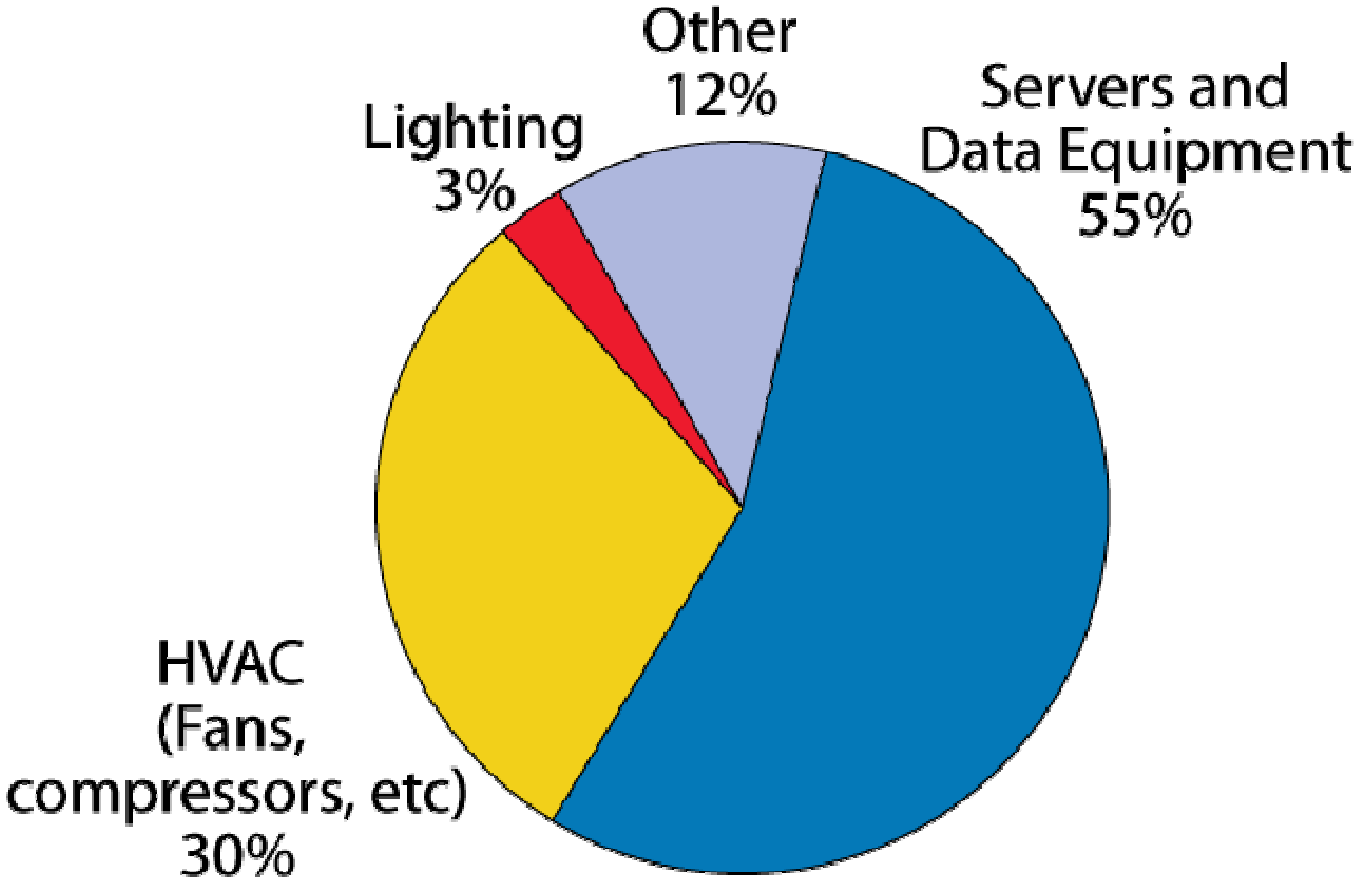
Data Centers and servers account for 61 billion kWh, or 1.5% of total U.S. electricity consumption



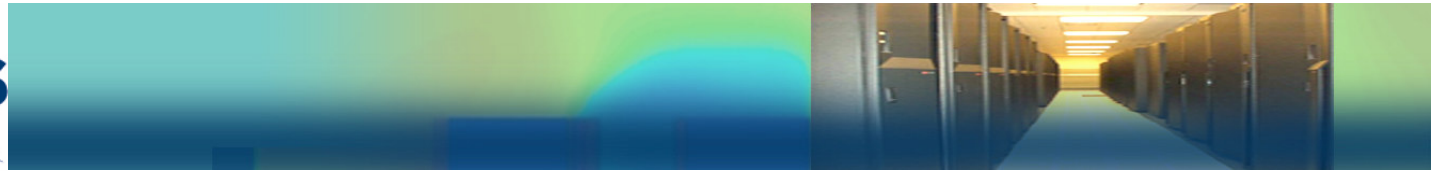
Utility Focus (until recently)

- Audits and incentives targeted at cooling systems:
  - High-efficiency equipment (chillers, pumps, fans, etc.)
  - Variable frequency drives
  - Air and water economizers ("free cooling")
- What we were missing:
  - Anything having to do with operations "inside the white room"
  - Desktop and network systems

What We Were Missing



Energy use in a high-performance data center (LBNL/PG&E Study)

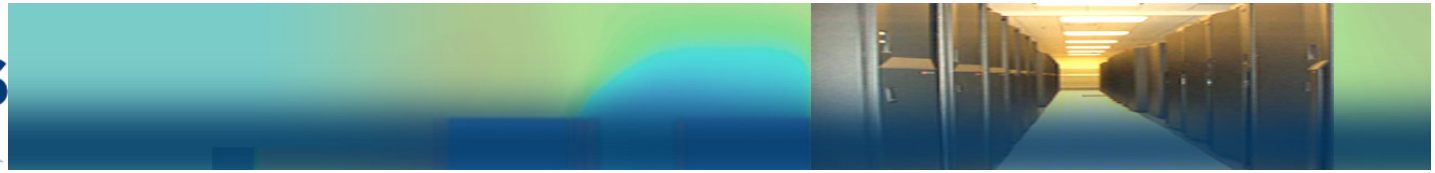


Industry activities

- Green Grid
- Climate Savers Computing Initiative
- 80Plus
- ENERGY STAR
- Standard Performance Evaluation Corp (SPEC)
- DOE research initiatives

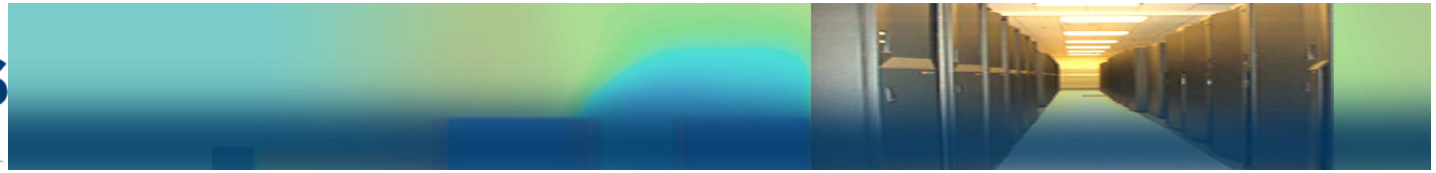
Utility IT EE Coalition

- Industry agrees that a third to a half of data center energy use can be addressed through cost-effective, reliable energy efficient technologies and strategies



Systems thinking

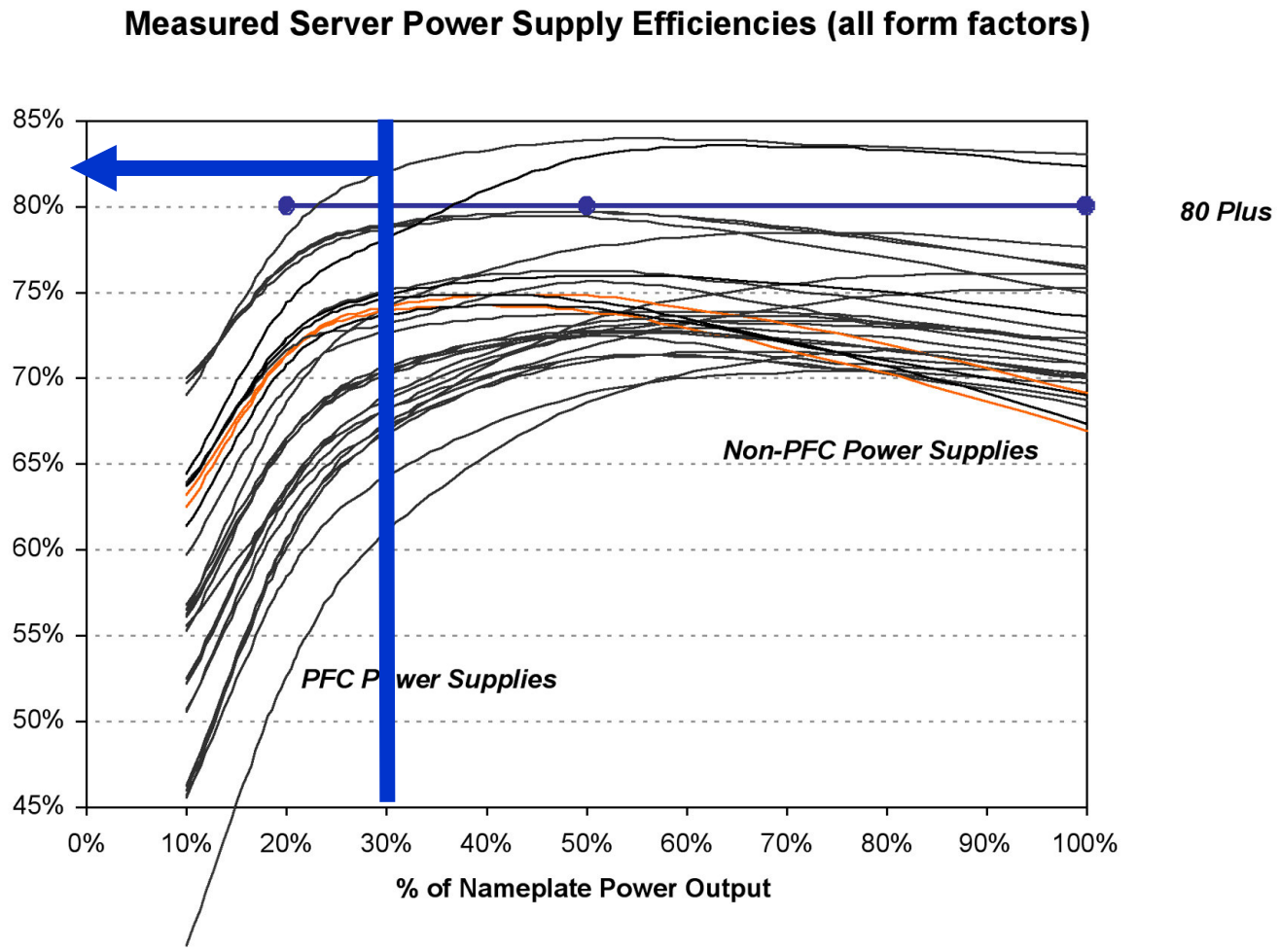
- Applies to all types of IT systems (single PC to co-location data center)
- Hardware
  - IT equipment efficiency (chips, power supplies, UPS systems, etc)
  - Purchasing and disposal
- Software / management
  - Server virtualization
  - PC power management
- Design / architecture
  - Thin clients
  - Network
- Efficient cooling
  - Temperature and humidity requirements
  - Air flow management
  - Free cooling

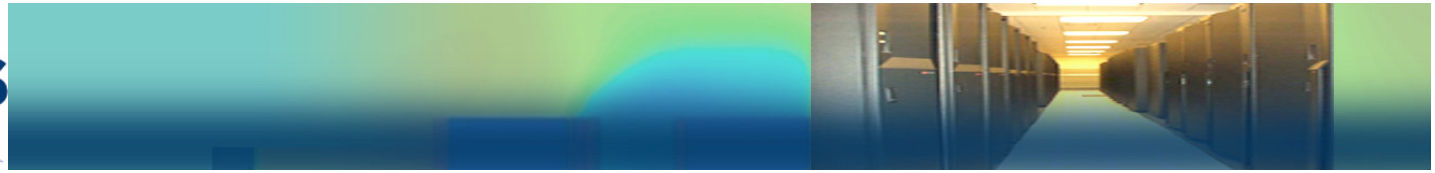


Desktop “efficiency” - hardware

- ENERGY STAR 4.0 specification
  - July 2007
  - Desktops, Integrated Computers, Desktop-Derived Servers and Gaming Consoles
  - Standby (Off Mode), Sleep Mode, Idle State, Active
  - 25% savings
- Efficient power supplies
  - ENERGY STAR
    - Internal power supplies: 80% minimum efficiency at 20%, 50%, and 100% of rated output and minimum Power Factor 0.9
  - 80Plus
  - Climate Savers Computing Initiative
- Monitor >> get rid of CRT monitors, look for most efficient LCD monitors
  - ENERGY STAR 5.0 for monitors, scheduled Oct 2009

Measured power supply efficiency





Desktop “efficiency” - software

- PC power management, 25-75% more savings
  - Urban legends
    - Turning computers on and off is bad
    - Screen savers save energy
  - Installed on all computers, simply enable
  - Network options
    - Free versions (ENERGY STAR)
    - Self developed scripts
    - Licensed versions features (tracking savings, reporting)

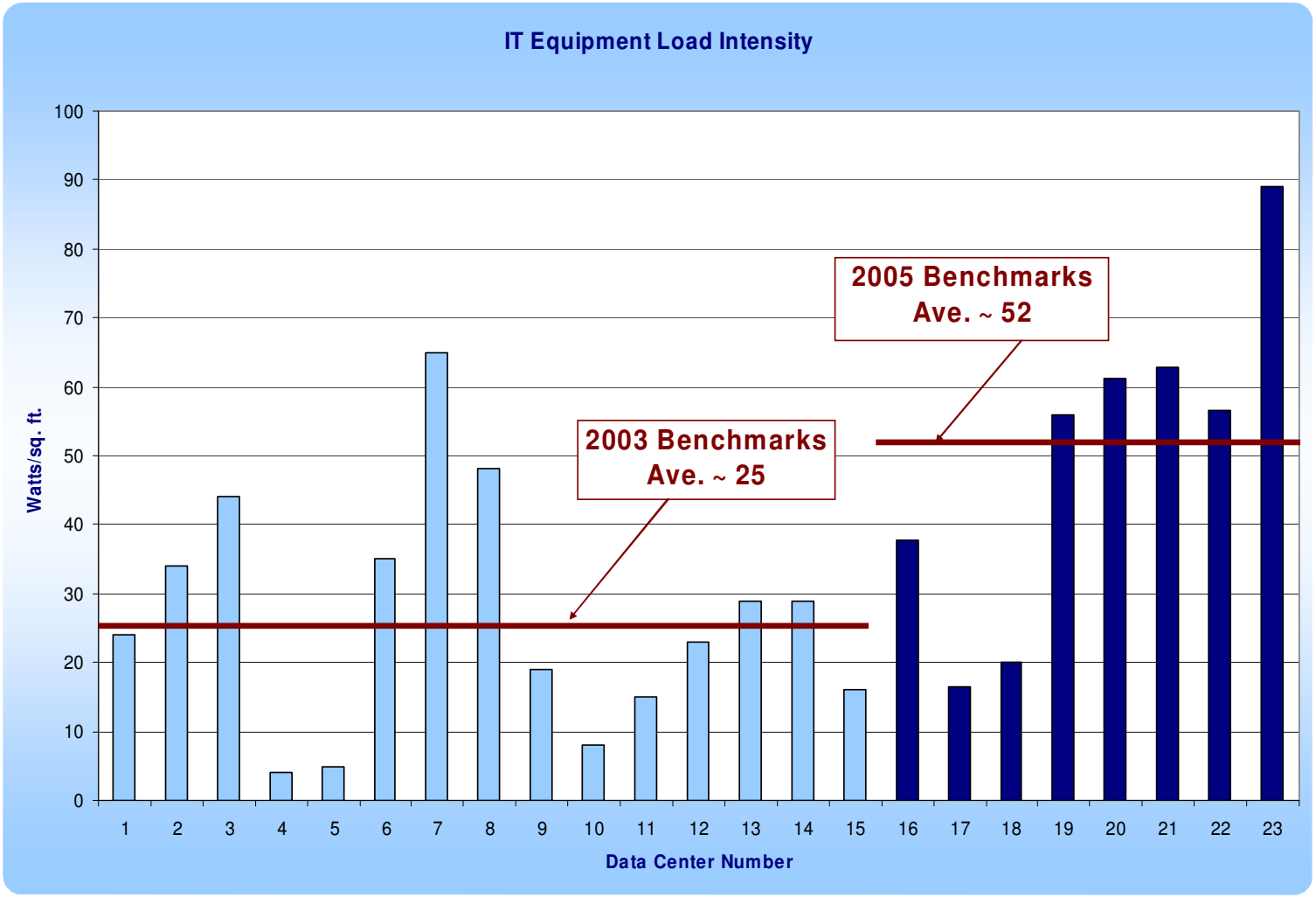
Design - Architecture

- Thin client
  - Typical Desktop Computer, 75 – 100 Watts, $500
  - Typical Laptop Computer, 10 – 15 Watts, $1,000
  - Typical Thin Client, 4 – 6 Watts, $300
- Typical energy savings for implementation of a thin client network
  - Replace 50 generic workstations with 50 thin client terminals
  - 55% energy savings

Data center efficiency opportunities

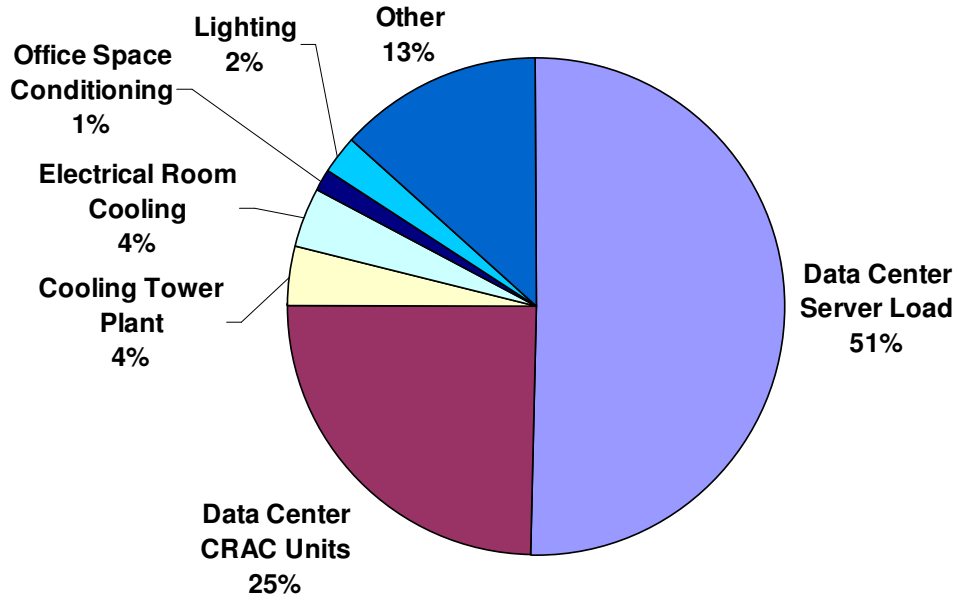
- Hardware
  - Efficient power supplies
  - Efficient UPS systems
  - Optimized redundancy strategies
- Computing operations / software
  - Server consolidation and virtualization
  - Active load management
- Cooling
  - Environmental conditions
  - Airflow management
  - Free cooling
  - Optimized chilled water plants

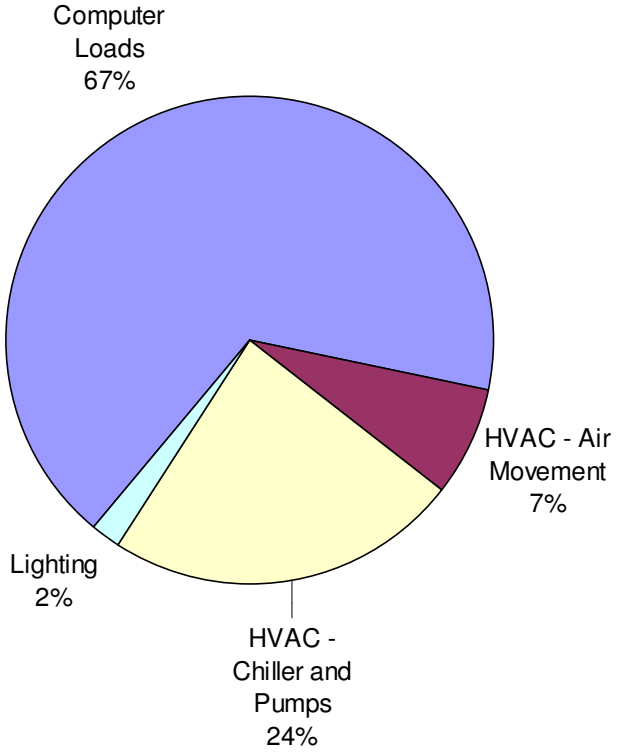
Benchmarking: IT equipment load density



Your mileage will vary

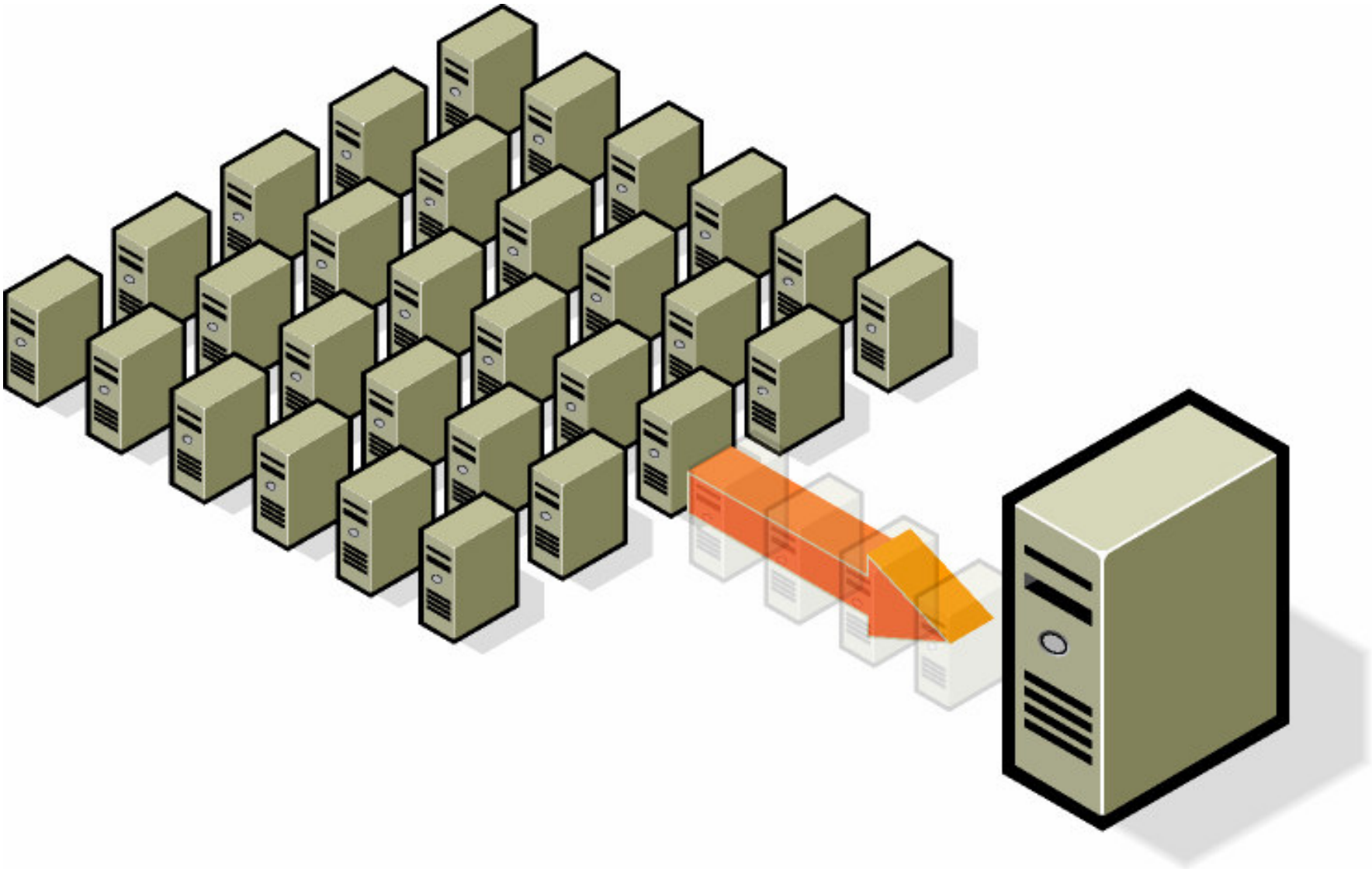
The relative percentages of the energy actually doing computing varied considerably.



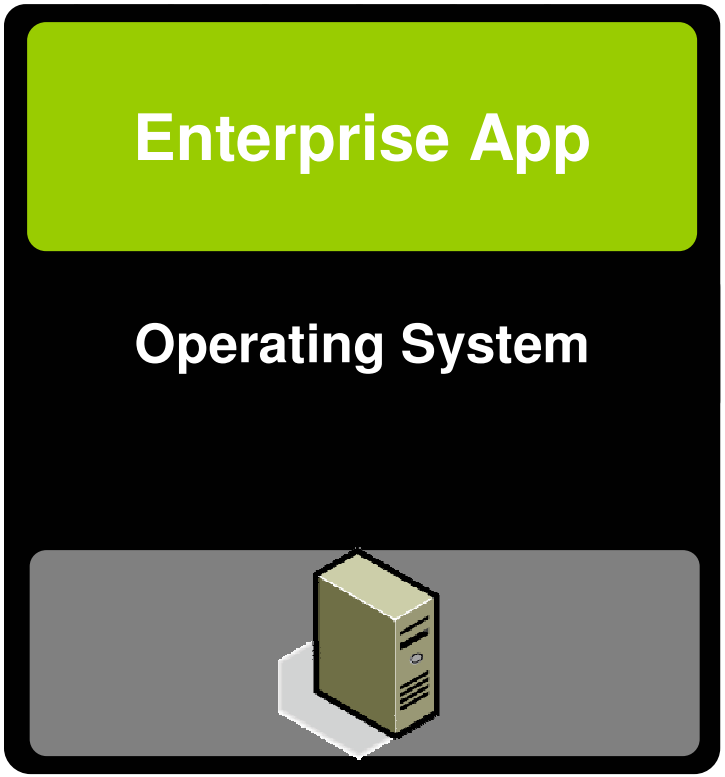


City of Fort Collins

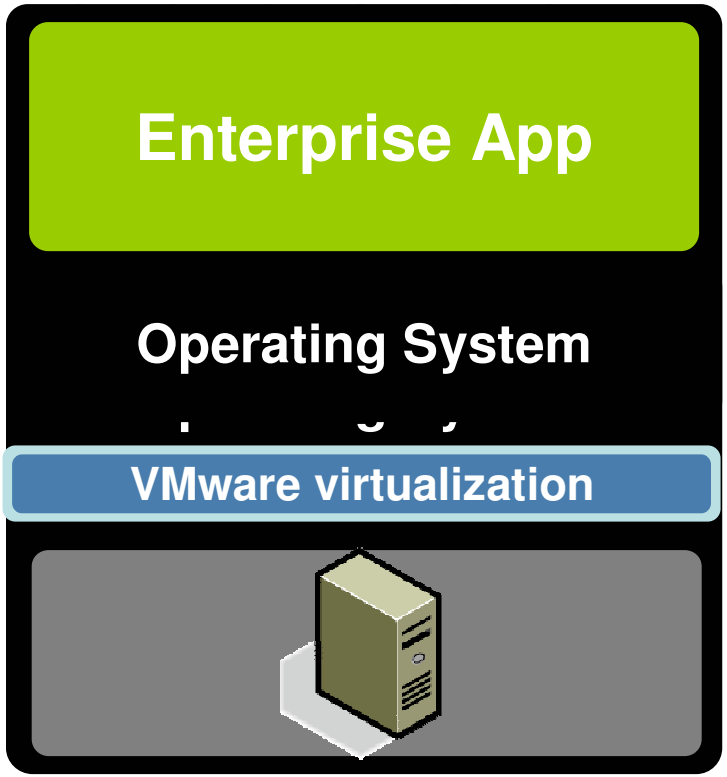
Server virtualization



First Things First:
Virtualization decouples software from hardware



First Things First:
Virtualization decouples software from hardware



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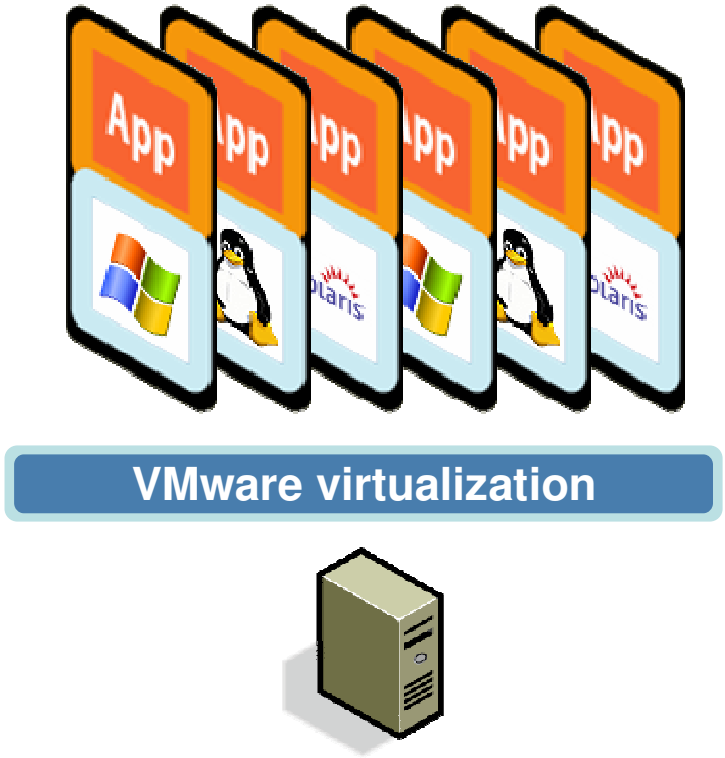
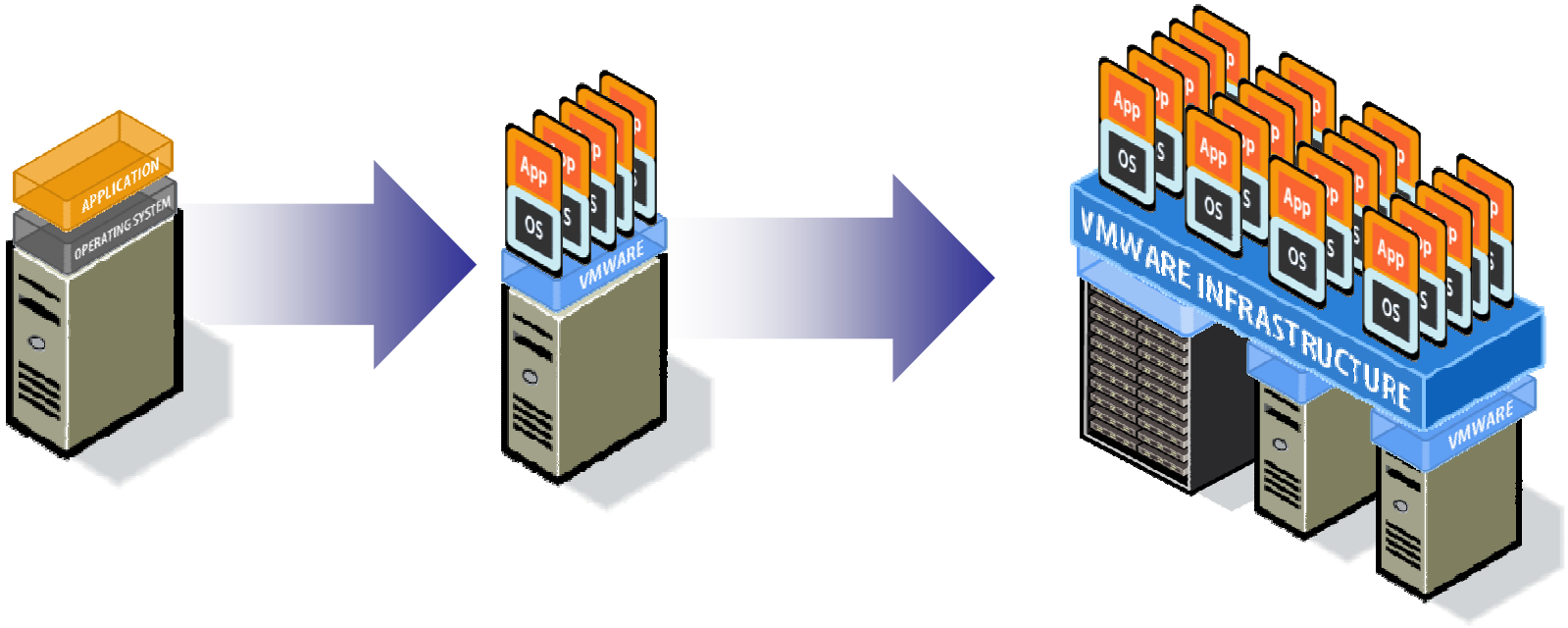


Virtualization: Fundamentally Better

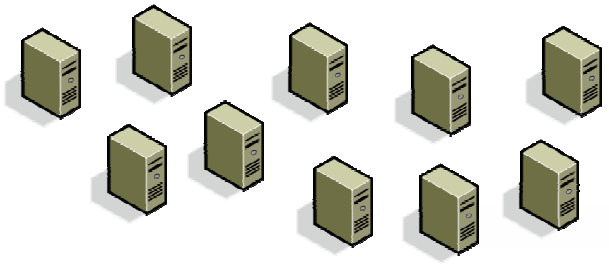
Run several operating systems on a single machine.

Create shared pools of resources to optimize your infrastructure.

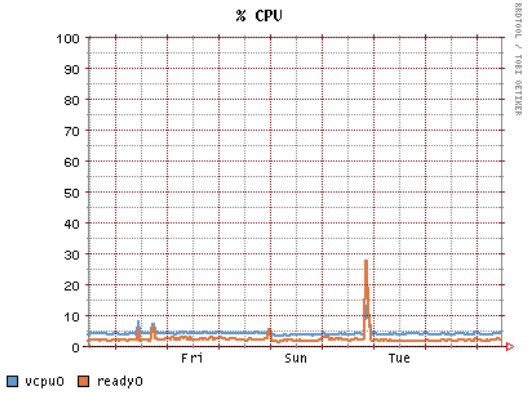


Solves the Challenge of Server Proliferation

Server Sprawl

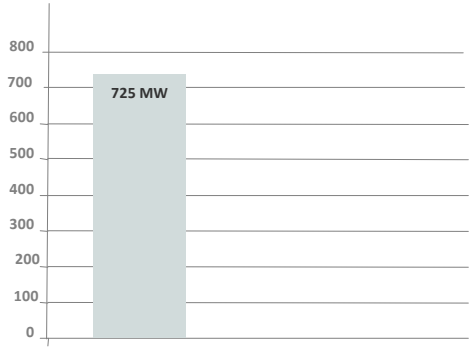


Low Utilization

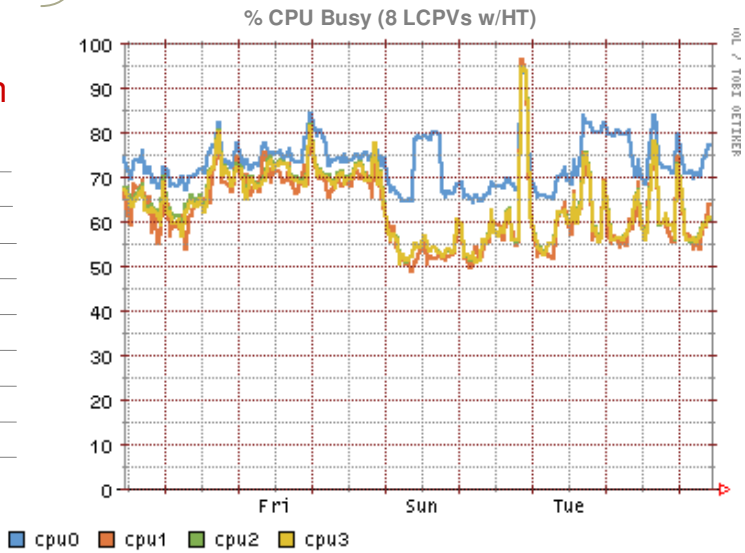


Avg. utilization rate/server

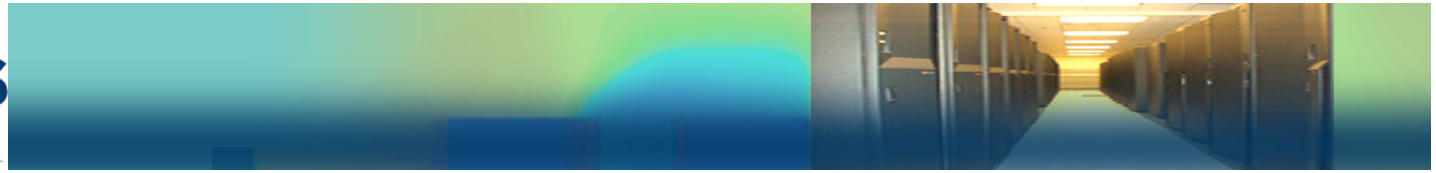
High Power Consumption



MegaWatts consumed:
100 servers per year



Higher Utilization



Reduce Costs and Power Consumption

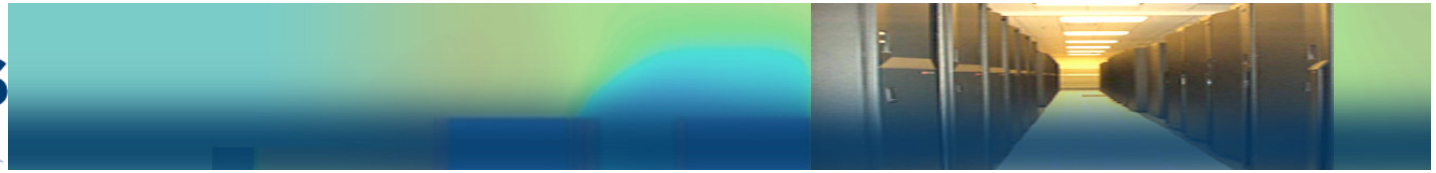
For every server virtualized, save…

- ~$500 and ~7,000 kWh / year
- 4 tons of CO_2 emissions / year

Plus

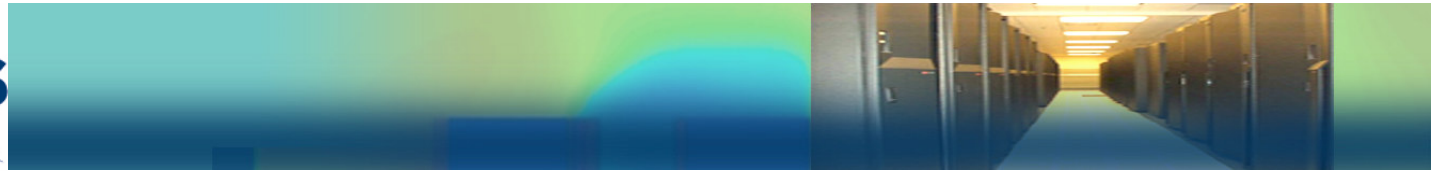
- Power down underutilized physical servers, saving 40%
- Desktop management reduces PC power usage 35% / year
- Utility incentives for energy efficiency through virtualization

10:1 consolidation = 80-90% less energy



City of Fort Collins – Virtualization Feasibility Study

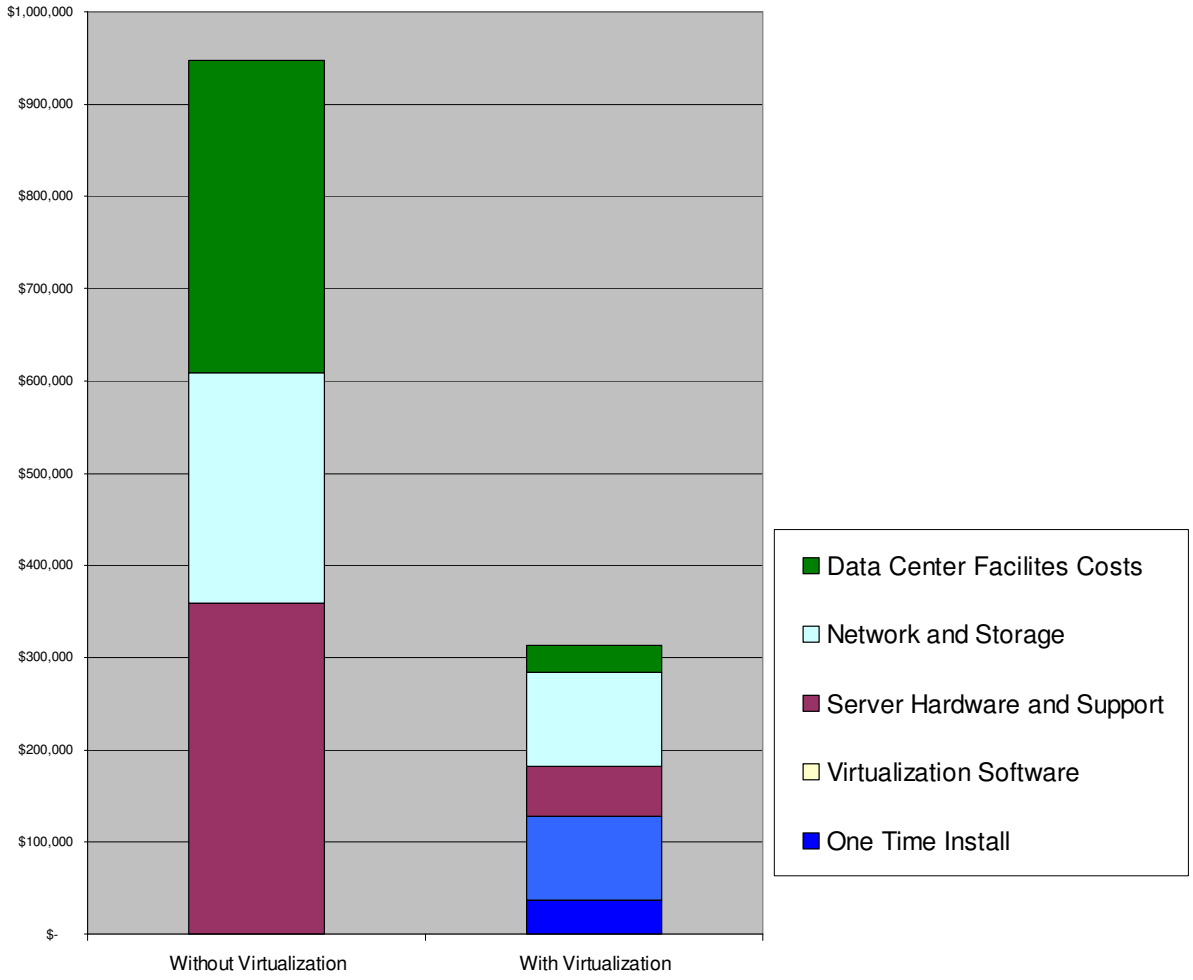
- Study process:
  - Develop server inventory
  - Install service monitoring software
  - Collect server load data – 5 weeks +/-
- 77 Windows servers – 50 identified as consolidation candidates
- Recommended consolidation via virtualization
  - Greater consolidation
  - High availability / Disaster recovery
- Options for implementing consolidation via virtualization (blade versus desktop derived servers)



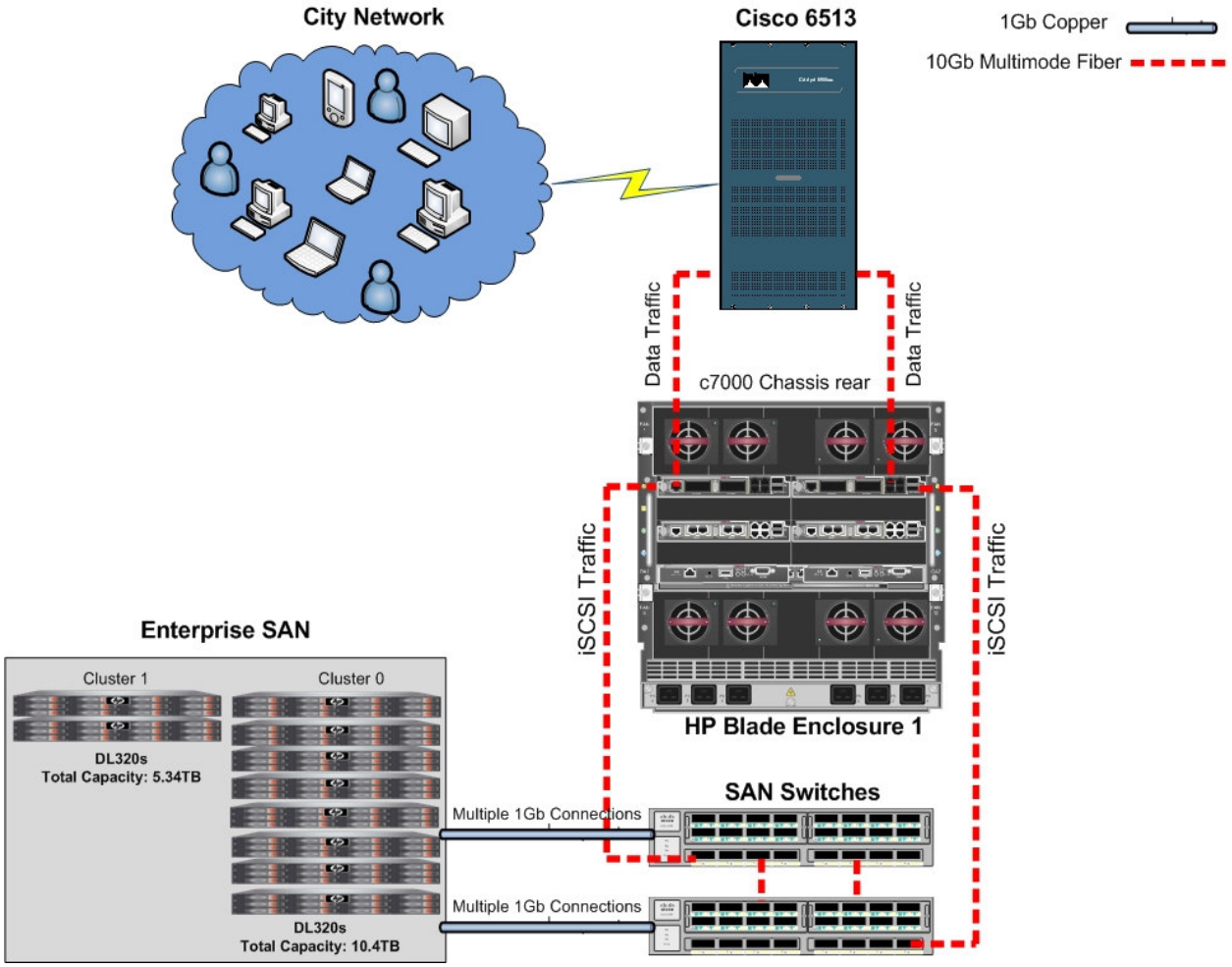
Projected 5 Year Data Center Costs

	Current Configuration	With Virtualization	Savings
One Time Install	-	37,000	(37,000)
Virtualization Software	-	91,050	(91,050)
Server Hardware and Support	359,000	54,128	304,872
Network and Storage	249,750	101,700	148,050
Data Center Facilities Costs	338,525	29,582	308,943
	947,275	313,460	633,815

Projected 5 Year Data Center Costs

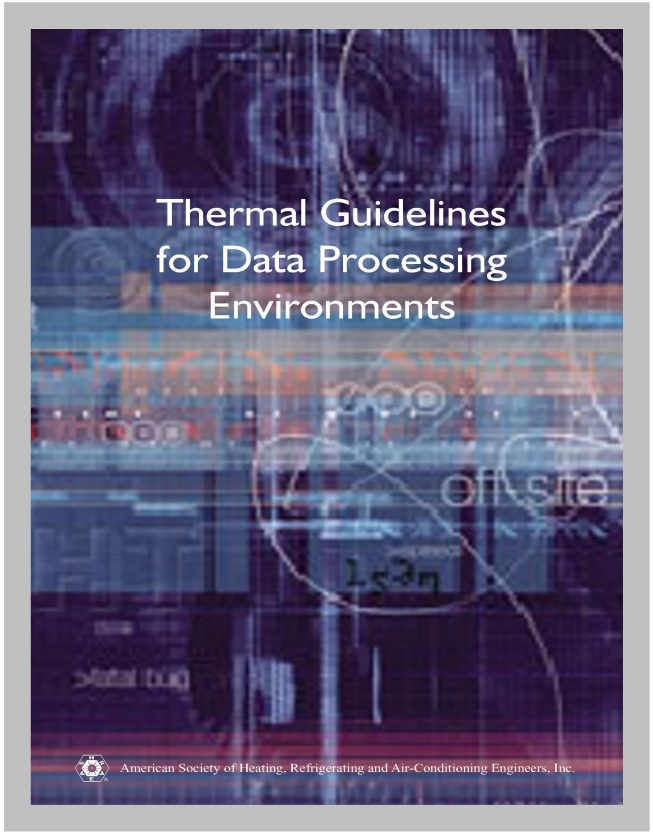


Fort Collins Blade Server / SAN Architecture



Environmental conditions

- ASHRAE - consensus from all major IT manufacturers on temperature and humidity conditions
- Recommended and Allowable ranges of temp and humidity
- Direct use of outside air

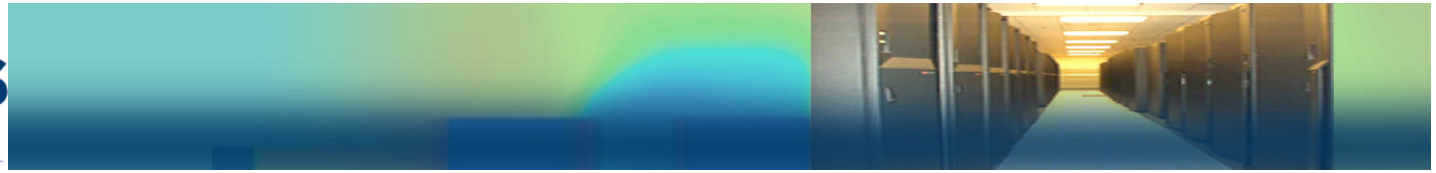


Design conditions at the inlet to IT equipment

Table 2.1
Class 1, Class 2 and NEBS Design Conditions

Condition	Class 1 / Class 2		NEBS	
	Allowable Level	Recommended Level	Allowable Level	Recommended Level
Temperature control range	59°F – 90°F[a,f] (Class 1) 50°F – 95°F[a,f] (Class 2)	68°F – 77°F[a]	41°F – 104°F[c,f]	65°F – 80°F[d]
Maximum temperature rate of change	9°F. per hour[a]		2.9°F/min. [d]	
Relative humidity control range	20% - 80% 63°F. Max Dewpoint[a] (Class 1) 70°F. Max Dewpoint[a] (Class 2)	40% - 55%[a]	5% to 85% 82°F Max Dewpoint[c]	Max 55%[e]
Filtration quality	65%, min. 30%[b] (MERV 11, min. MERV 8)[b]			

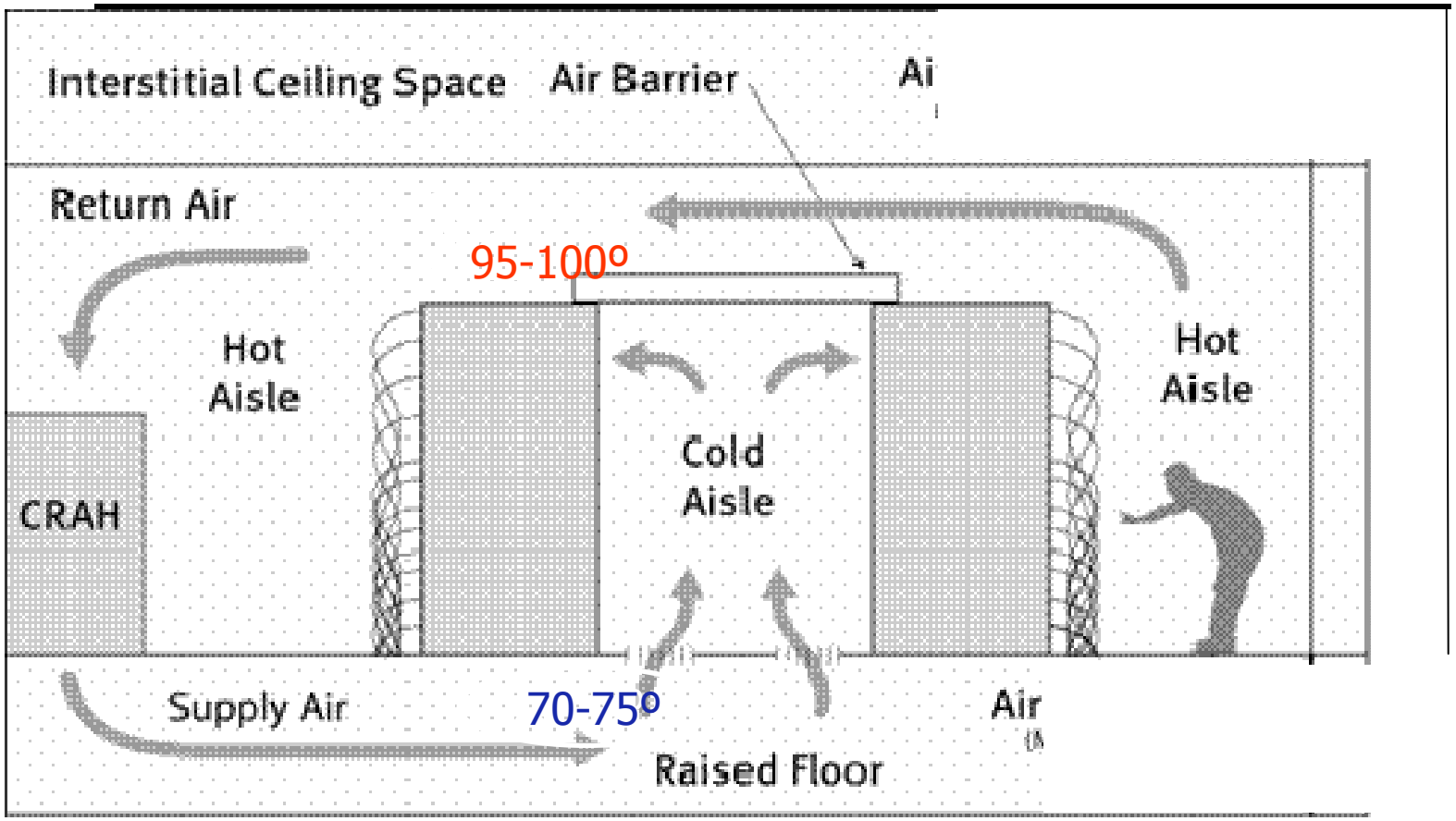
[a]These conditions are inlet conditions recommended in the ASHRAE Publication *Thermal Guidelines for Data Processing Environments* (ASHRAE, 2004).
[b]Percentage values per ASHRAE *Standard* 52.1 dust-spot efficiency test. MERV values per ASHRAE Standard 52.2. Refer to Table 8.4 of this publication for the correspondence between MERV, ASHRAE 52.1 & ASHRAE 52.2 Filtration Standards.
[c]Telecordia 2002 GR-63-CORE
[d]Telecordia 2001 GR-3028-CORE
[e]Generally accepted telecom practice. Telecom central offices are not generally humidified, but grounding of personnel is common practice to reduce ESD.
[f]Refer to Figure 2.2 for temperature derating with altitude



Airflow - Isolating hot or cold aisles

- Energy intensive IT equipment needs good isolation of “cold” inlet and “hot” discharge
- Computer room air conditioner airflow can be reduced if no mixing occurs
- Overall temperature can be raised in the data center if air is delivered to equipment without mixing
- Coils and chillers are more efficient with higher temperature differences

Cold aisle containment, underfloor supply



PRPA data center case study

- Poorly designed data center cooling
  - Poor performance, high energy use
- Improvements
  - Hot/cold aisle isolation
  - Blanking plates
  - Sealing racks against air infiltration
  - Creating common duct
  - Moving thermostats
  - Raised temperature settings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Scalar i2000


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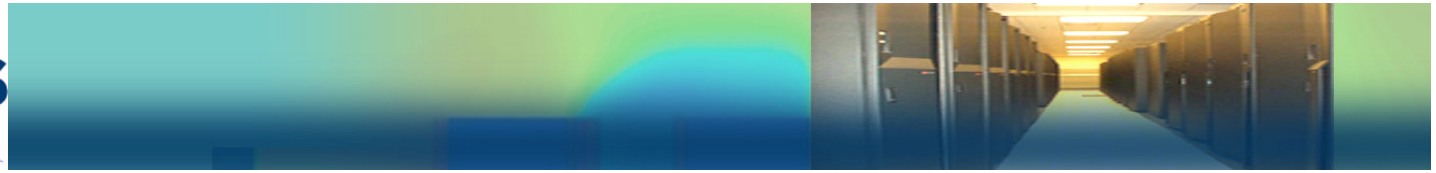
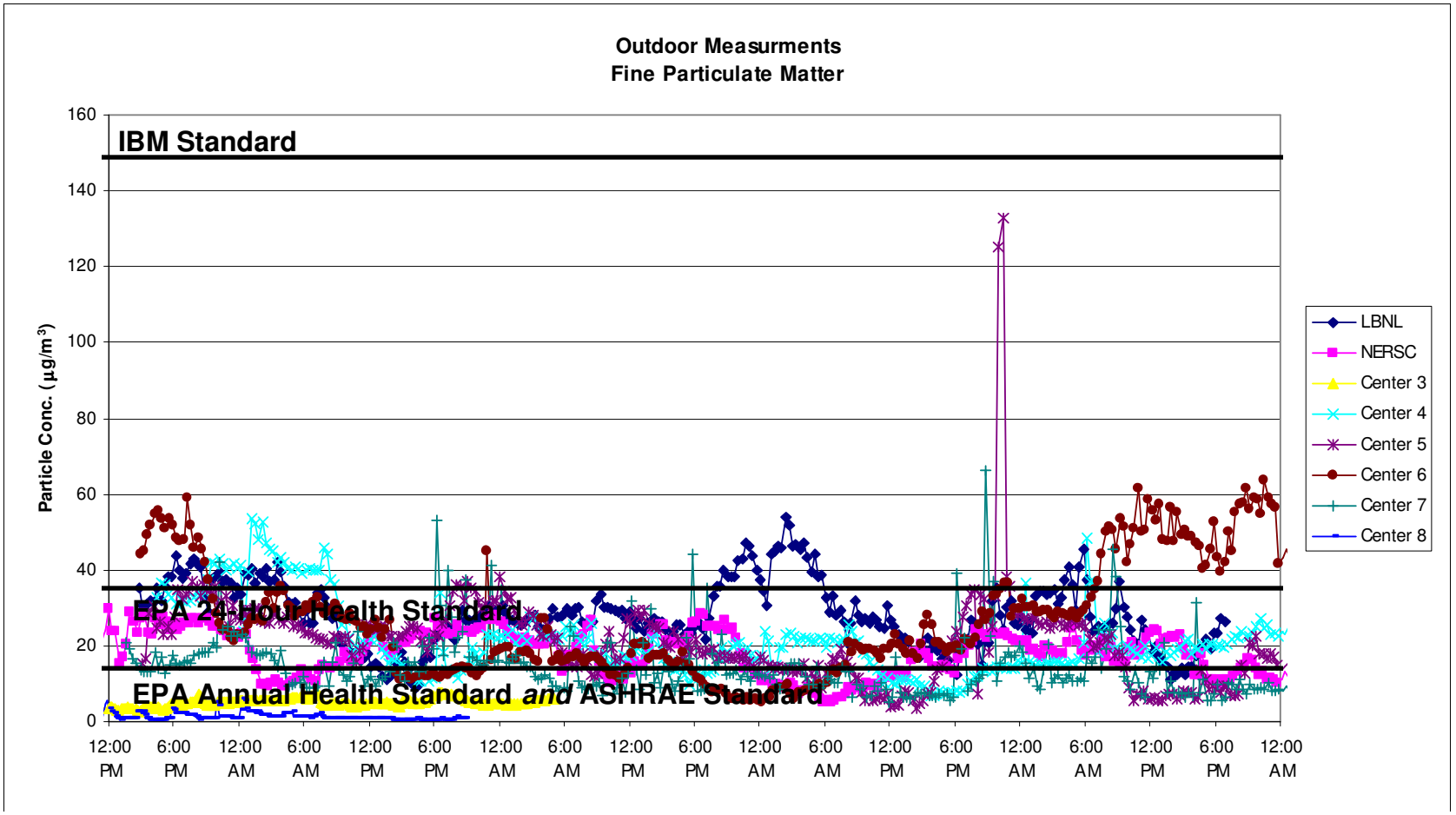


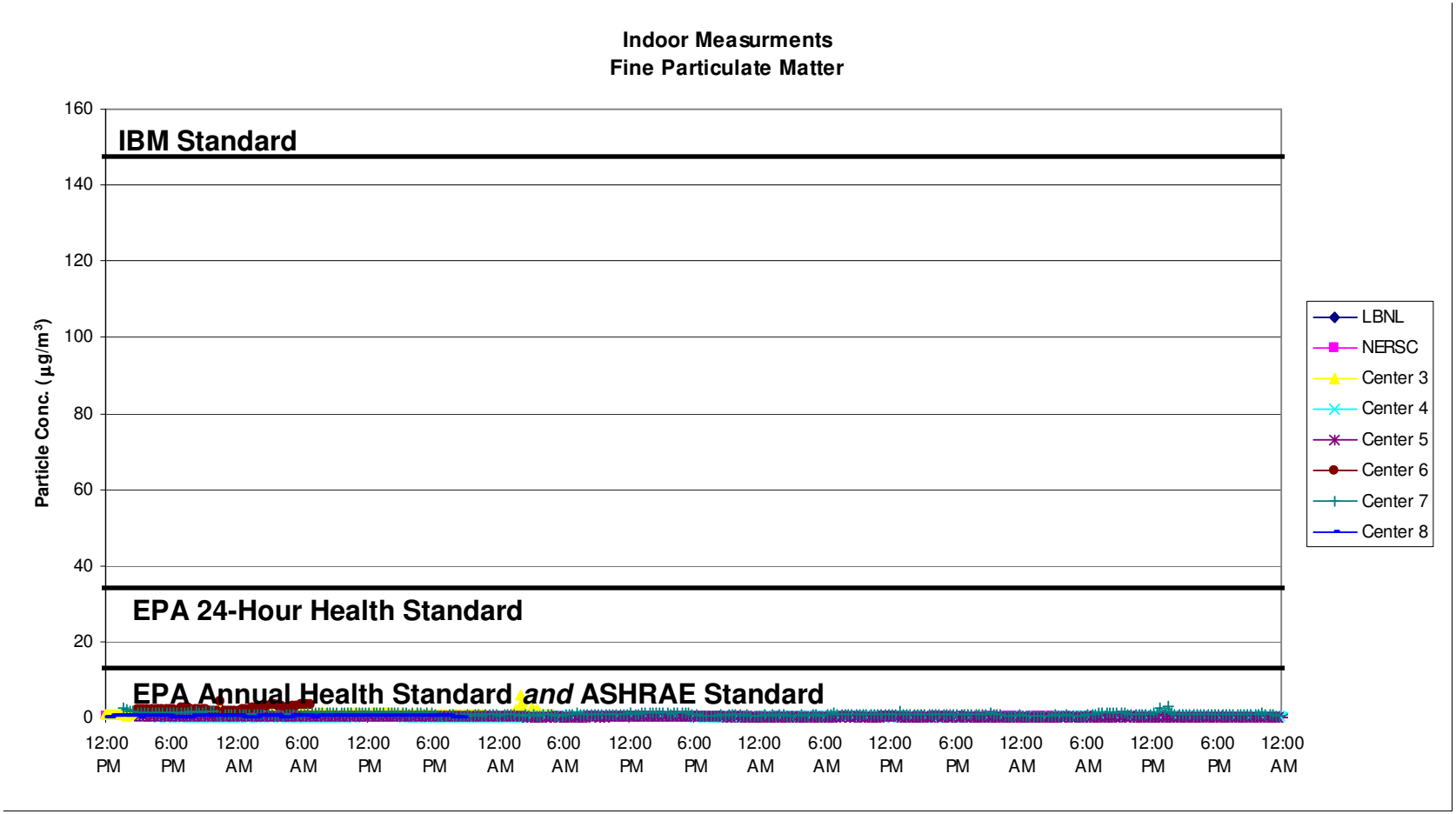
Outdoor air

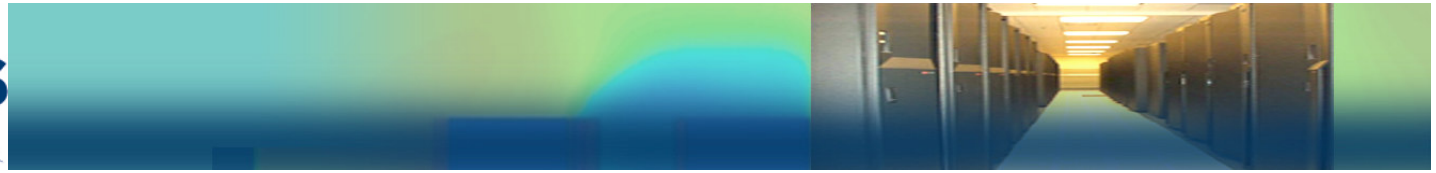
- Use outside air for data center cooling
- Traditional opposition
  - Outside air is “dirty”
  - Humidity will create static electricity problems

Outdoor measurements



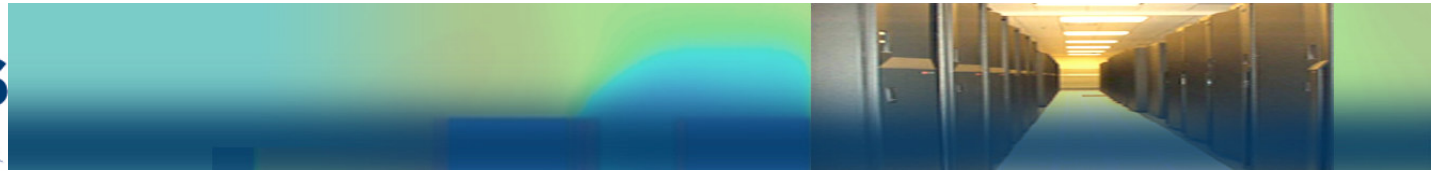
Measurements inside the centers





Lower humidity limit

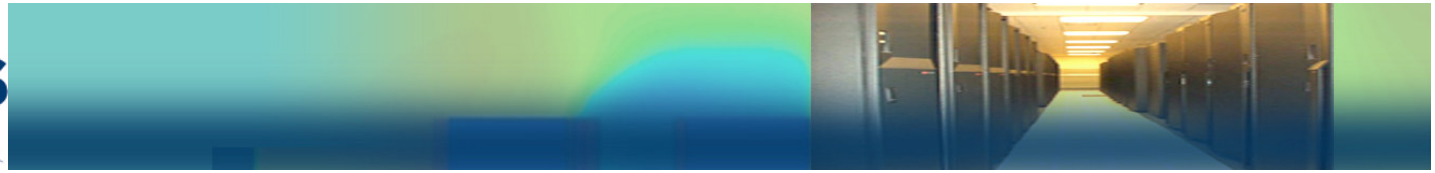
- Mitigate electrostatic discharge (ESD)
  - Recommended procedures and equipment
  - Industry practices
    - Telecom industry has no lower limit
    - The Electrostatic Discharge Association has removed humidity control as a primary ESD control measure in their ESD/ANSI S20.20 standard
  - Humidity controls are a point of failure and are hard to maintain
  - Many data centers operate without humidification
- Avoid humidity control if at all possible
  - High humidity is usually limited by cooling coil dew-point temperature
  - Low humidity limit is not well supported



Materials and resources perspective

- EPEAT certification program (Electronic Product Environmental Assessment Tool)
  - Green Electronics Council program (www.epeat.net)
  - EPEAT is an implementation of the IEEE 1680 standard
- EPEAT rates PC eco-friendliness according to 51 criteria and awards three levels of certification, bronze through gold.
  - Example bronze certification = products have to meet 23 criteria, including Energy Star certification, 65% recycled material, and an end-of-life disposal program
- Action steps
  - Choose vendors that offer take-back or recycling programs for obsolete IT equipment
  - If not participating in a take-back program, recycle electronics with reputable company
  - Proper disposal of electronics is required by law, including a local ban (www.fcgov.com/ewaste)
  - Consider PCs on the EPEAT list
  - Consider upgradability and reuse when selecting equipment

City of Fort Collins



Cloud Computing

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SPECIAL REPORT August 4, 2008, 12:01AM EST

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How Cloud Computing Is Changing the World

A major shift in the way companies obtain software and computing capacity is under way as more companies tap into Web-based applications

by Rachael King

View Slide Show

At first, just a handful of employees at Sanmina-SCI (SANM) began using Google Apps (GOOG) for tasks like e-mail, document creation, and appointment scheduling. Now, just six months later, almost 1,000 employees of the electronics manufacturing company go online to use Google Apps in place of the comparable Microsoft (MSFT) tools. "We have project teams working on a global basis and to help them collaborate effectively, we use Google Apps," says Manesh Patel, chief information officer

SPECIAL REPORT
CEO Guide to Cloud Computing

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- Cloud Computing: Small Companies Take Flight
- Enter the Cloud with Caution
- Best and Worst Places for Data Centers
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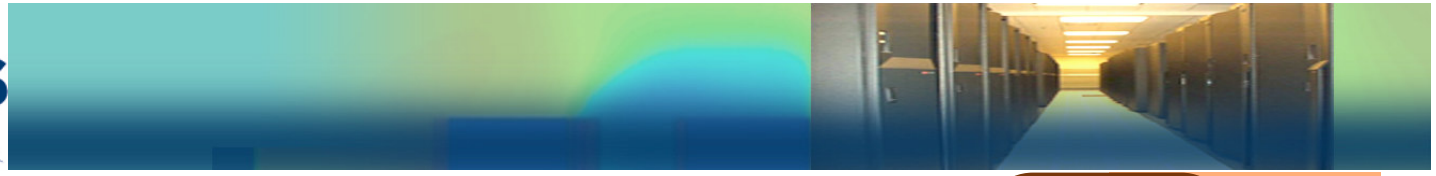
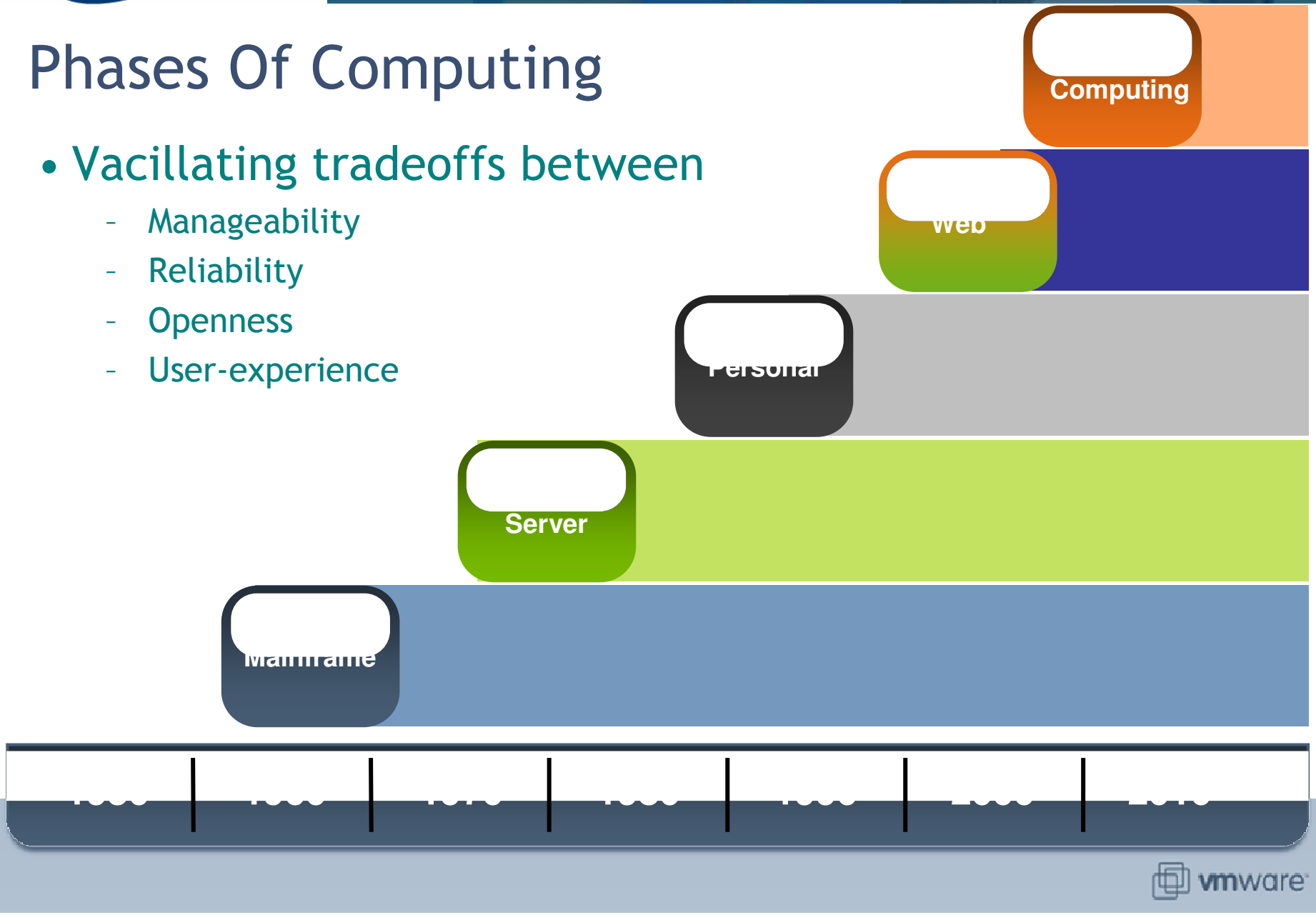


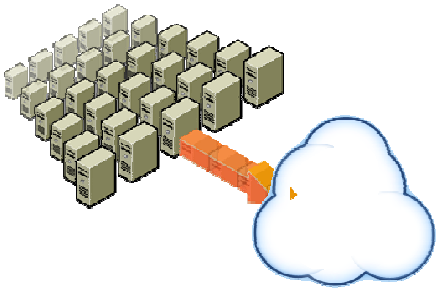
Phases Of Computing

- Vacillating tradeoffs between
  - Manageability
  - Reliability
  - Openness
  - User-experience



vmware

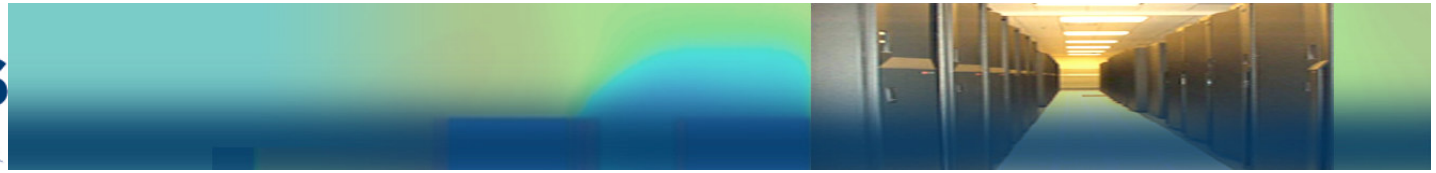
How Do We Define The Cloud?



- Resource on demand
- Pay for what you use
- Accessible as a loosely-coupled service
- Scalable and elastic
- Improved economics due to shared infrastructure and elasticity

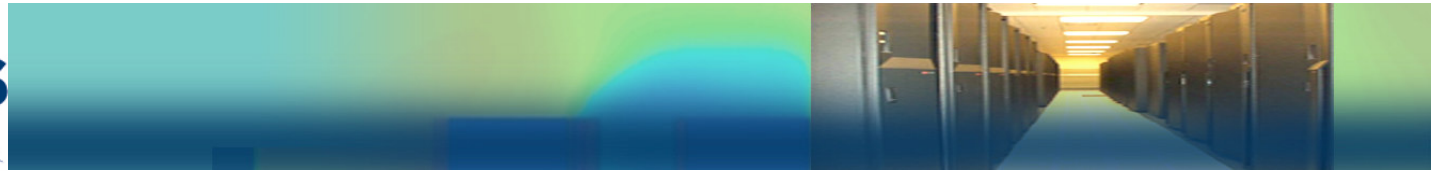
> Cloud computing comes into focus only when you think about… a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software. Cloud computing encompasses any subscription-based or pay-per-use service that, in real time… extends IT's existing capabilities.

InfoWorld



Information technology efficiency strategies

- Join Climate Savers Computing Initiative
  - Purchase ENERGY STAR desktops and servers
  - Implement power management
- Spec LCD monitors that exceed ENERGY STAR standards
- Consider thin client/desktop virtualization
- Begin or accelerate adoption of virtualization technology – consolidate server and storage equipment
- Evaluate free cooling strategies for your data center
- Institute airflow management best practices; raise supply air temperature; widen humidity set points
- Think cradle to grave for IT purchases



Resources

- fcgov.com/business-eps
- climatesaverscomputing.org
- energystar.gov
- 80plus.org
- pge.com/hightech/itfacility.shtml
- hightech.lbl.gov/datacenters
- thegreengrid.org
- spec.org
- epeat.net
- fcgov.com/ewaste