

Impact of IT Upgrades on Energy Usage and Operational Cost

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Experts for Your Always Available Data Center

White Paper



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EXECUTIVE SUMMARY

With the high costs of power, energy efficiency has rapidly become a critical consideration when evaluating data center performance. It is, perhaps, second only to performance when deciding upon data center facility and network design. Higher energy consumption is a recurring cost that can add dramatically to operating expense over time. Furthermore, devices that consume more power require more cooling which not only further increases energy costs but impacts the physical design of the data center.

Data center designers, manufacturers of data center facility infrastructure, and information technology (IT) infrastructure manufacturers have recently flooded the market with estimated energy efficiency savings through the use of various facility and product design techniques.

Through this white paper, PTS Data Center Solutions (PTS) personnel validate these energy efficiency savings estimates using the upgrade of the IT system within its own data center facility and operations as a test bed. A systematic plan and analysis was put in place to this end. First, a baseline measurement of IT performance, capacity, and energy consumption was undertaken. Then, PTS underwent a re-design of its IT systems with a goal of reducing energy consumption while at the same time increasing capacity without sacrificing performance. Lastly, the results were measured to assess confirmation of expectations.

In the end, PTS consolidated its server footprint by approximately 60% using virtualization technologies, implemented managed switch and network security devices, and implemented an iSCSI SAN solution. At the same time, IT energy consumption was reduced by 24%, yielding a 26% drop in facility power consumption.

Our conclusion is that these results are not anecdotal in that the energy savings realized as a result of this study are completely scalable with larger, more complex data center and computer room facilities. Additionally, these energy savings may be realized without sacrificing IT performance and systems availability, while improving overall systems capacity.

Overview

This White Paper documents PTS' strategy in operating its own high-efficiency computer room. Specifically, it analyzes the effect of server virtualization on energy consumption. It provides specifics of a series of IT infrastructure modifications and upgrades made to the PTS IT infrastructure located at 568 Commerce Street, Franklin Lakes, New Jersey 07417 to improve the energy efficiency within this environment, without sacrificing performance or availability. Prior to the IT infrastructure modifications, specific facility related measurements for power and cooling were made as a base-line. After completion of all modifications, power and cooling measurements were made again and a comparison to the base-line was performed.

Results of the comparison are a basis for the impact of IT infrastructure modifications upon facility energy usage costs. The intent is to verify the most impacting energy savings measure that can be implemented is to reduce that actual load itself. Furthermore, analysis will show the energy saving correlation between IT energy usage and that of the facility. Assuming there is a correlation, any realized energy saving as a result of PTS' small environment can be correlated to any larger, more complex data center environment.



Background

According to PTS' historical data, typically 50% of the power consumed by data centers is the IT load itself while the remaining 50% is consumed by the supporting infrastructure. The result is a data center with a Power Usage Effectiveness (PUE) rating of 2.0. More practically, the typical range PTS observes across all large and small environments is similar – between 1.5 and 3.0.

As seen in Figure 1, a typical 1,000 kW (1 MW) loaded data center's supporting infrastructure consumes approximately 1,670 kW of energy due to poor design and operating decisions.

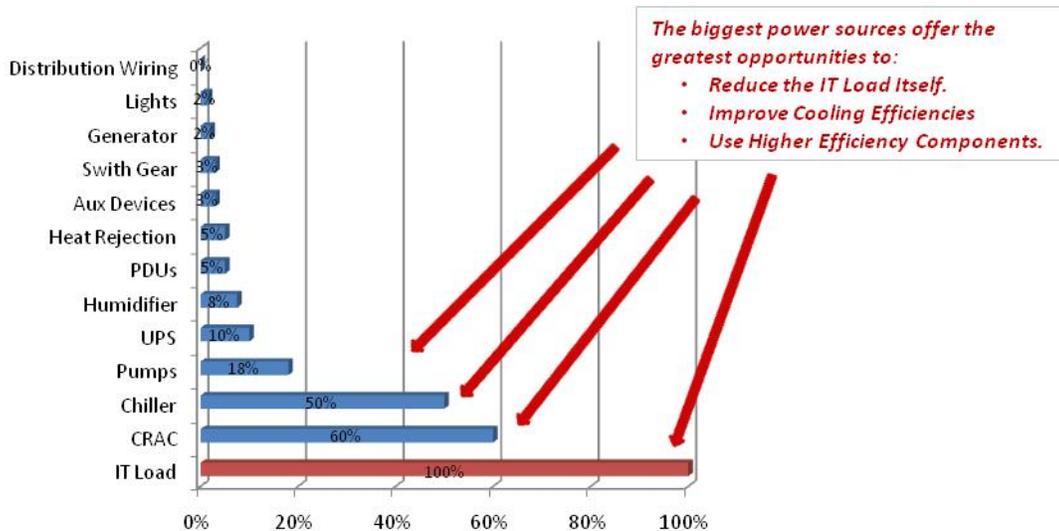


Figure 1: Example of a PUE = 2.7 Power Consumption Profile

The lesson to be learned – no matter how good or bad the starting PUE may be, the potential for improving energy efficiency is always the same. The best opportunities to improve energy efficiency and reduce cost structure include:

- **Reduce the IT Load Itself.** Clearly there are a number of ways to reduce the power load requirements through the use of efficient IT network elements, server virtualization, storage consolidations, etc.
- **Choose an Effective Cooling Approach.** Given that air conditioner and heat rejection technologies are energy hogs, choosing the appropriate cooling configuration will have a significant impact on data center total energy usage.
- **Use High-Efficiency Electrical Components.** Specifying and replacing low-efficiency electrical components throughout the data center with high-efficiency electrical components will positively impact energy consumption.

Obvious from Figure 1, reducing the IT load itself is the best way to reduce energy consumption and positively impact operating costs. This is true because any drop in consumption by the load yields a corresponding reduction in the energy consumption of the supporting infrastructure, including air conditioning, heat rejection equipment, electrical component heat dissipation losses, fire protection/detection, and lighting.

The next most important decision is choosing the appropriate cooling approach given IT load requirements. Choosing a cooling solution is a delicate balance between the capital costs of the approach versus the operating costs of the approach. Deciding what approach is best is outside the scope of this paper.

Finally, utilizing the highest efficiency electrical components yields the next best savings. Obviously, the largest power consumption devices (i.e., the uninterruptible power supply (UPS), switch gear, transformers, and stationary power distribution units (PDUs)) will have the largest positive impact.

Given the above, virtualization, and other consolidation technologies, is the obvious first choice for a methodology to reduce the actual IT load. Researching this topic leads to a vast array of opinions as to the potential for energy savings as a result of implementing virtualization and consolidation technologies. In an effort to discern the reality, PTS began to formulate a plan to use its existing computer room operations as a proving ground for implementing various IT improvement initiatives that result in reduced energy usage and, therefore, cost savings.

This white paper and the program described within focuses on that approach.

Project Approach

Table 1 provides an outline of the approach used by PTS to develop IT Infrastructure Improvements.

Table 1: Outline of IT Infrastructure Improvements Project Approach

Item	Activity
1	Implement monitoring platforms to track and trend power usage and IT performance.
2	Document existing conditions including IT and facility configuration, IT capacity and performance, and energy consumption.
3	Maintain the facility configuration, but re-design the IT environment to improve systems capacity, maintain performance, and reduce energy consumption using blade servers with virtualization technologies, an iSCSI storage area network, and managed switch / network security devices.
4	Estimate the expected benefits of IT infrastructure improvements in #3 above.
5	Implement the blade server/virtualization, iSCSI SAN, and network upgrades.
6	Document the new IT configuration, capacity, performance, and energy consumption.
7	Analyze the results of #1-6 above.
8	Assess ability to correlate the results for larger data center and computer room spaces. Finally, outlines steps for further facility and/or IT improvements.

Measurements for Real-Time Energy Efficiency

According to ASHRAE the level of measuring and monitoring energy consumption in a data center is determined mainly by the capital cost, data accuracy and resolution, and the final-use of the data. Based upon these factors, the following levels of measurement are provided as a guideline:

- **Minimum Practical Measurement** – manual measurement, data recording and reporting
- **Best Practical Measurement** – some automation with respect to data gathering and recording
- **State-of-the-Art Measurement** – fully automated measurement, data gathering, reporting, and trending

PTS' Best Practical Measurement

This level of measurement requires some manual measurement, recording, and/or reporting of the data. Furthermore, the accuracy of the data is not such that it can be used for revenue and investment grade energy audits. However, it is good enough for evaluating various operational conditions.

For PTS, it the most economical method of measurement was an automatic data monitoring and collection system with a manual data correlation and analysis step. For this study, all power and cooling support infrastructure systems were individually metered for data recording purposes, including utility service feeds, UPS, PDU, rack PDU, CRAC, Chillers, computer room lights, and various other monitoring, CCTV, and fire detection/suppression systems that support computer room operations. The readings from all sub-systems were incorporated into the final calculations and related to average power consumption.

First, all of the circuits feeding the support infrastructure were identified by location and circuit. From there, a branch circuit monitoring platform was selected to meter the support infrastructure components. Real-time monitoring was accomplished by utilizing a protocol converter to convert the modbus protocol devices to be read by the PTS SNMP monitoring platform.

The computer room IT loads were metered at both the power strip and receptacle level. The selected power strips were configured to report data to our SNMP monitoring platform. The SNMP monitoring platform polled all of the devices for data every 5 minutes.

By implementing best practical measurement (real time monitoring), PTS was able to track the energy consumption of all support infrastructure and IT infrastructure as changes were made throughout the project.

IT & Facility Conditions – Prior to IT Upgrades

Infrastructure

The IT network infrastructure in place for PTS Data Center Solutions prior to any IT modifications related to energy efficiency is shown in Figure 2.

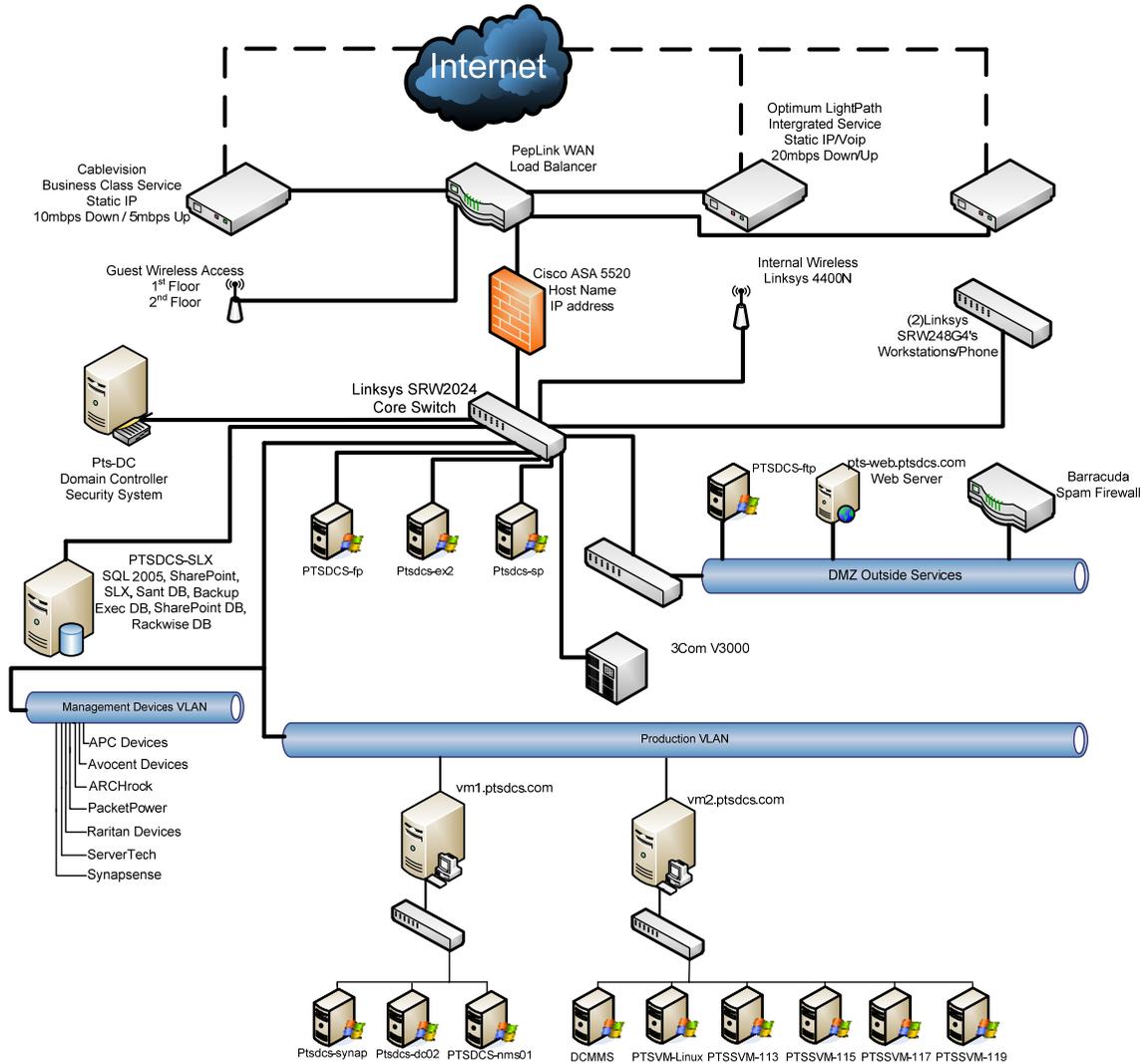


Figure 2: PTS Baseline Network Structure

Existing Conditions

PTS' facility and IT infrastructure consisted of the following:

Facility

Facility conditions included:

- **Room Configuration:** A single row of cabinets comprised of two (2) server cabinets, one (1) UPS cabinet, one (1) PDU cabinet, one (1) CRAH, and one (1) network cabinet. Air curtains are installed at both ends isolating the hot aisle. Additionally, blanking panels are utilized in each cabinet thereby further reducing air mixing.
- **Power Configuration:** APC Symmetra PX 30kW N+2 UPS with internally redundant power, battery, and control modules, as well as its matching PDU.
- **Cooling Configuration:** APC in-row computer room air handler (CRAH) with supply-side control and a corresponding outdoor chilled-water package. The system operates with a chilled water temperature of 50°F with a 10°F approach (the approach temperature is the difference between what temperature the chiller starts making chilled water and the temperature at which it stops. In PTS' case it starts at 60°F and stops at 50°F) and a CRAH cooling set point of 77°F at the rack inlet, which results in an IT equipment inlet temperature of 75-80°F. The fact that PTS is comfortable utilizing an operating conditioner at the upper limit of ASHRAE's guideline for its own data center is a matter for another white paper.
- **Current Load:** The current IT load was 3,510 watts at the time it was measured, which represented 17.5% of the UPS' redundant capacity.

Information Technology

IT conditions included:

- **Network:** Multiple managed Linksys switches with limited basic capabilities. A 24-port gigabit switch is operated as the core with two 10/100 48-port switches for user access.
- **Network Security:** Cisco ASA 5520 firewall with no remote access VPN configured.
- **Storage:** Servers with direct attached storage (DAS) drives. No network attached storage (NAS) or storage area networks (SAN) in place. Total storage capacity is:
 - System Total: 491 GB - Data Total: 2156 GB
 - System Used: 139 GB - Data Used: 591 GB
 - % Utilization: 28.4% - % Utilization 27.4%
- **Server:** Twelve (12) physical servers including the following Dell models: 750, SC1425, 2850, 2900, and 2950. Operating systems included: Microsoft Windows Server 2003, Standard Edition; Microsoft Server 2003, Standard x64 Edition, and Microsoft Windows Server 2003, Web Edition. Processors included: Single Core, Dual Core, and Quad Core.

- Virtualization: Two (2) VMware ESX 3.5 servers housing several virtual remote workstations, production Microsoft Windows servers, and test servers.
- Performance Metrics:
 - Average CPU Utilization was measured 2.1% while peak CPU Utilization was measured to be 5.5%.

Critical Deficiencies

The following list summarizes our conclusions as to the problems and potential areas of improvement available in the PTS' IT environment:

1. Majority of servers are underutilized
2. Several servers have overloaded systems partitions
3. There is inadequate switch port availability and management
4. There is significant stranded storage capacity
5. Extensive time is spent managing the IT environment

Baseline Power Consumption Data

PTS Power Consumption Data for the period of March 14 – 21, 2010 (baseline, prior to IT modifications) is shown in Table 2 and Figure 3. As expected the largest power consumption is driven by the IT load itself at % (network, server, other IT) of total volume. The next largest source of power consumption is the chiller plant at 30% of total volume.

The PTS Computer Room PUE was 1.69 prior to any IT infrastructure modifications.

Table 2: PTS Primary Computer Room – Power Consumption Data, March 14-21, 2010

Item	Measurement (Watts)	%
PDU	95.94	2%
Other IT loads	559.15	9%
Network	933.15	16%
Server	2,018.27	34%
Chiller	1771.83	30%
CRAH	156.58	3%
Lighting	91.83	2%
UPS	313.99	5%
Total Load	5,940.74	100%
Total Non-IT Load	2,430.17	41%
Total IT Load	3,510.57	59%
PUE	1.69	
DCiE	0.59	

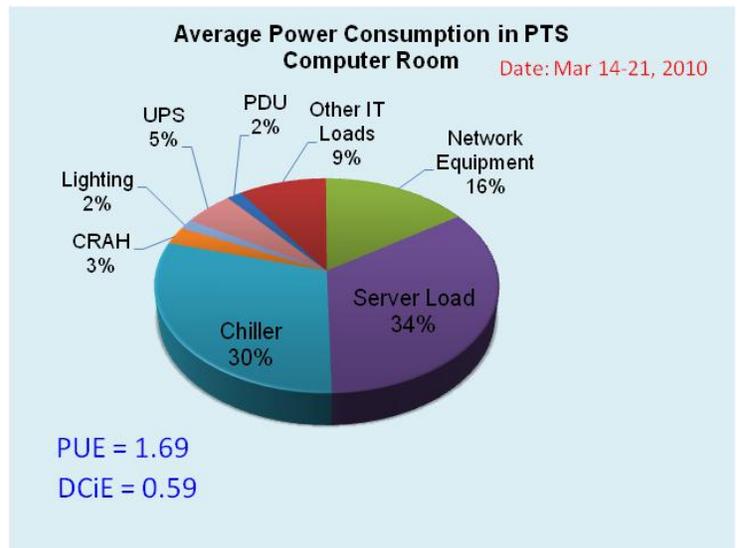


Figure 3: Average Power Consumption, PTS Computer Room, March 14-21, 2010

Re-design Strategy and Expected Results

Overview

As previously stated, the primary focus of the re-design effort was to reduce the energy consumption of the IT infrastructure itself. This would additional energy savings at the facility support infrastructure level. At the same time, the intent was to increase IT systems capacities, ease management of these systems, and not adversely affect performance and/or availability.

In the end, the best overall re-design strategy was determined to be a deployment of a true virtual server environment to reduce physical server sprawl. Ultimately, this strategy would reduce the server footprint, provide an easily expandable system, improve the server switched network, and centralize server and storage management. As a result, we expected to see improved processor utilization, improved storage utilization, and a reduction in overhead for operating the computer room environment.

The main goal for the facility was not to re-design any systems within it at all to maintain a specific operating baseline. However, we expected to see realize energy saving from the reduced IT load as a result of lower cooling energy usage as well as lower losses in all power distributing electrical components.

The remainder of this section provides an overview of the types of technologies considered for both the IT and Facilities modifications.

Server

- Physical rack servers were discounted because the blade server approach provided server, power, and cooling scalability in a single enclosure. This simplified management of the IT maintenance contracts, power, and cooling architecture.
- Blade enclosure was also chosen to centralize server location and management.
- Standardized on Advanced Micro Devices (AMD) processors based on market research and cost savings for comparable processing power.
- Dell was chosen to provide an integrated solution and single maintenance contract for IT equipment.

Virtualization

- VMware was selected based upon existing implementation in the PTS network.

Storage Area Network (SAN)

- Dell EqualLogic PS Series iSCSI storage array with (16) 450GB SAS drives and dual power supplies was selected for:
 - Ease of use
 - Ease of management interface.
 - SME performance

- Cost per Terabyte (TB) of storage

Network and Network Security

- Enterasys Networks switches were considered for the office network. Due to budget constraints, the office switched network was not implemented as part of this project.
- A Blade Network Technologies switch was chosen as a best in class data center switch based on price and performance.
- Enable VPN on our existing ASA firewall appliance.

Facility

- There were no physical changes to any facility and/or supporting infrastructure.

Implementation & Testing

The upgraded PTS network is shown in Figure 4. It includes the migration, per VMware assessment, from 11 hardware servers to five (5) physical or hardware servers housing a total of three (3) ESX 4.0, and two (2) Microsoft Windows Servers. The structure includes the following:

- Domain controller (Blade Center dedicated server)
- ESX 1, ESX 2, and ESX 3 hosts
 - ESX 1 and ESX 2 are setup as a cluster with HA and common storage (Blade Center)
 - ESX 3 houses the DMZ servers.
- Database Server (Power Edge 2950)

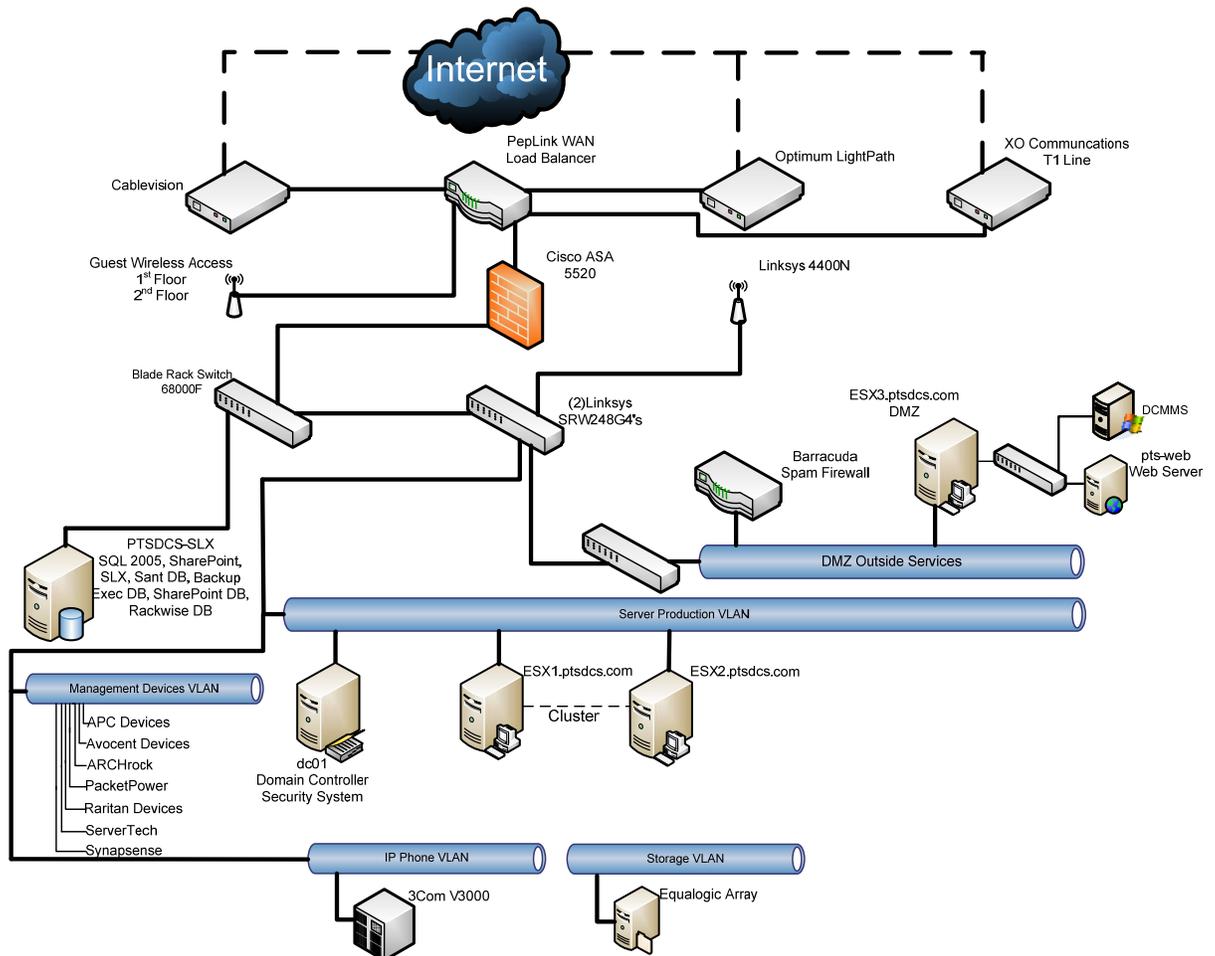


Figure 4: PTS Revised Network Structure

New Conditions

PTS' facility and IT infrastructure, **after re-design and implementation**, consists of the following:

Facility

Facility conditions included:

- Room Configuration: No change.
- Power Configuration: No change.
- Cooling Configuration: No change.
- Current Load: The current IT load was 2,654 watts at the time it was measured, which represented 13% of the UPS' redundant capacity.

Information Technology

IT conditions included:

- Network: A Blade Networks 48-port Gigabit Ethernet switch is now the core switch. One 10/100 switch was maintained for the phone system and management devices. The Linksys Gigabit switch was re-allocated for user workstation access.
- Network Security: Cisco ASA 5520 firewall, remote access VPN enabled.
- Storage: A Dell EqualLogic SAN was deployed for centralized storage management.
 - System Total: 612 GB - Data Total: 1694 GB
 - System Used: 325 GB - Data Used: 806 GB
 - % Utilization: 53.0% - % Utilization 47.6%
- Server: Five (5) physical servers are utilized. One (1) of the Dell 2950 rack based servers was redeployed and one (1) of the Dell 2950 rack based servers was maintained. A new Dell Blade Center was purchased with three (3) blades. Operating systems included: VMWare ESX 4.0 (vSphere); Microsoft Windows Server 2003, Standard Edition; Microsoft Server 2003, Standard x64 Edition; *Microsoft Windows Server 2008 R2 Standard*; and, Microsoft Windows Server 2003, Web Edition. Processors included: Dual and Quad Core.
 - Virtualization: Three (3) VMWare ESX 4.0 host servers housing remote workstations, production servers and DMZ servers.
 - Performance Metrics:
 - Average CPU Utilization was measured 9.3% while peak CPU Utilization was measured to be 21.2%.

IT Systems Re-Design Power Consumption Data

PTS Power Consumption Data for the period of August 2nd – 9th, 2010 is shown in Table 3 and Figure 5. As expected the largest power consumption is driven by the IT load itself at 60% (network, server, other IT) of total volume. The chiller package is the next largest source of power consumption at 26% of total.

The PTS Computer Room PUE was 1.65 after IT infrastructure modifications.

Table 3: PTS Primary Computer Room – Power Consumption Data, August 2-9, 2010

Item	Measurement (Watts)	%
PDU	72.90	2%
Other IT loads	487.26	11%
Network	533.65	12%
Server	1,633.15	37%
Chiller	1,132.63	26%
CRAH	189.47	4%
Lighting	54.62	1%
UPS	286.22	7%
Total Load	4,885.53	100%
Total Non-IT Load	1,735.84	40%
Total IT Load	2,654.06	60%
PUE	1.65	
DCiE	0.60	

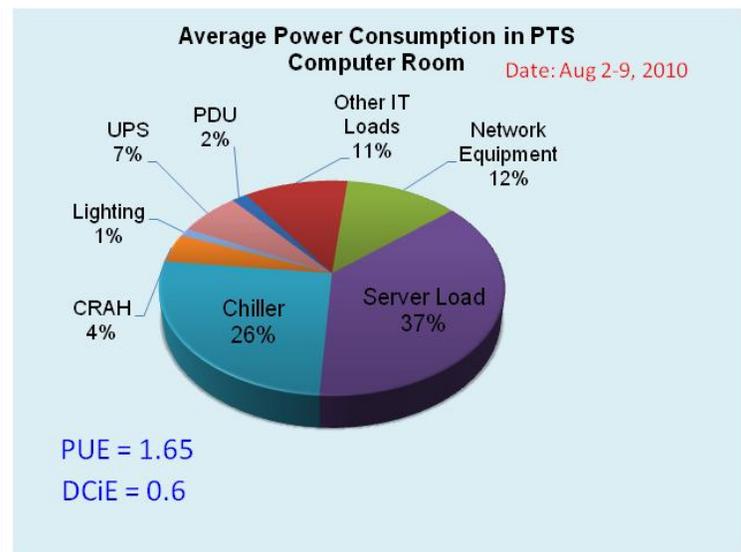


Figure 5: Average Power Consumption, PTS Computer Room, August 2-9, 2010

Interpretation of Results and Next Steps

Overview

As a result of the re-design and implementation, all goals were met for the project including reducing the energy consumption of the IT infrastructure itself, and subsequently the support infrastructure, an increase in all IT systems capacities, an ease management of all IT systems, and neither performance and/or availability were adversely affected as a result of the changes.

The following is a summary of the realized improvements.

Network & Network Security

- The number of available network ports was doubled
- Switch management was improved
- The firewall was updated and VPN was enabled

Server & Virtualization

- Reduced (12) physical servers running (14) server instances to (5) physical servers running (14) server instances, resulting in a 60% reduction in physical servers.
- Increased of virtual server utilization from 14% to 64%.
- Increased average CPU utilization from 2.1% to 9.3% and peak utilization from 5.5% to 21.2%
- Eased sever management as well as new server deployment

Storage Area Network

- Centralized data storage and data storage management
- Increased system storage available 25%, from 491GB to 612GB
- Increased system storage utilization 89%, from 28% to 53%
- Decreased data storage available 21%, from 2,156GB to 1,694GB
- Increased data storage utilization 78%, from 27% to 48%

Facility

- There were no physical changes to any facility and/or supporting infrastructure
- Power consumption for all IT equipment was reduced by 857 watts (24%), from 3,510 watts to 2,654 watts
- As a result, power consumption due to cooling and power protection/distribution was reduced by 694 watts (29%), from 2,430 watts to 1,735 watts

- Therefore, overall facility power consumption was reduced by 1,551 watts (26%), from 5,941 watts to 4,886 watts
- This yields an annual savings of \$2,303.00 per year, assuming a blended utility rate of \$0.17/kWh and 7x24 operation

Figure 6 provides the results of the PTS computer room IT infrastructure upgrade as it pertains to changes in energy efficiency (power/watts). The change in IT load, cooling, and power loss is noted between March (baseline) and June 2010 when IT infrastructure changes were completed.

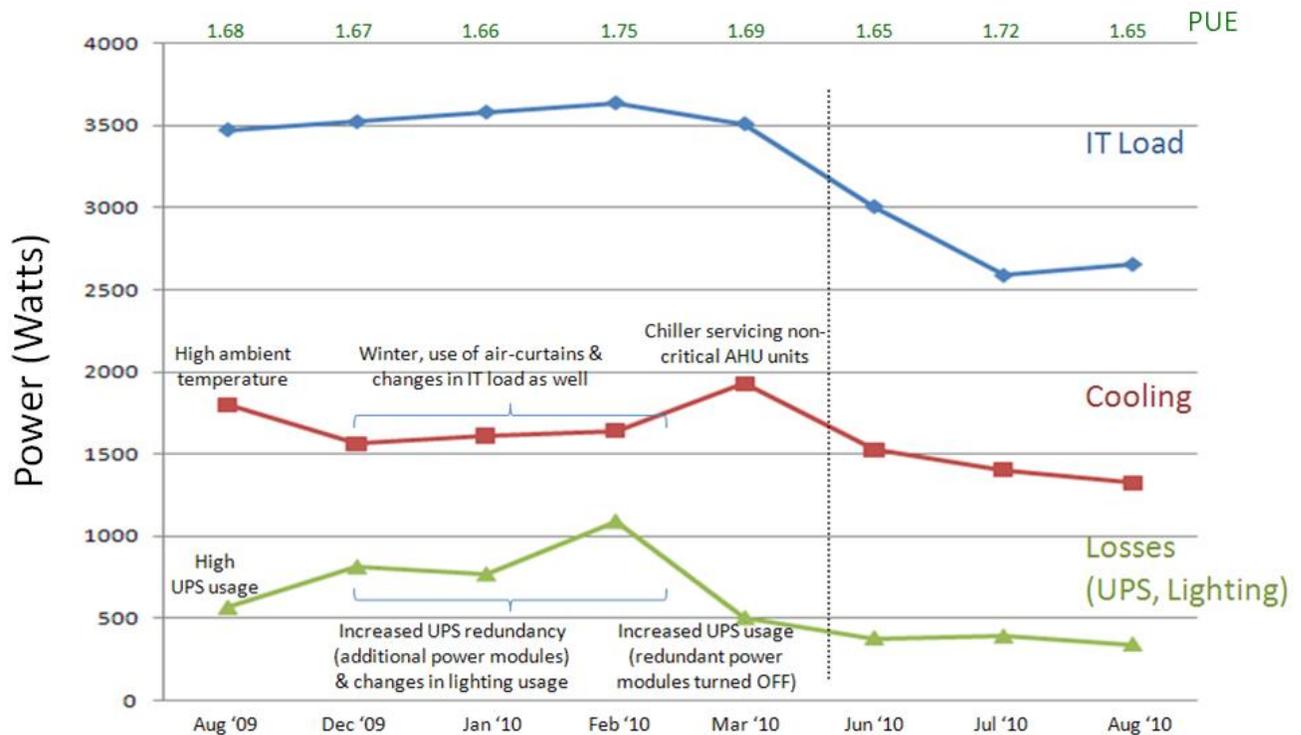


Figure 6: PTS Computer Room Energy Consumption Results

Conclusions

After reviewing the virtualization assessment before and after reports the following conclusions were identified:

- Utilizing virtualization technologies to consolidate physical servers is the best way to reduce overall energy consumption in a computer room environment.
- Every 1.0 watt power reduction in the IT equipment demand results in an additional 0.8 watt usage reduction as a result of cooling and electrical loss savings.
- Since the energy savings is a direct result of reduced server footprint, the results are entirely scalable as the IT and facilities environment expands. Meaning, if instead of

reducing physical server footprint from 14 to 5 (approximately 3:1), 150 could be reduced to 50, which would yield an annual energy savings of ~\$23K per year. And, this doesn't include indirect savings as a result of IT operations and management efficiency improvements.

Next Steps

As a result of this study, PTS is already underway evaluating additional energy savings improvements, including:

- Upgrading our aging chilled water package to a new system that will incorporate a water-side economizer option. This will allow PTS to 'free cool' at those times when the ambient condition is at or below our chilled water set point.
- Increasing the temperature of the chilled water supplied to our CRAH unit from 50°F to 55°F (and potentially 60°F). While this will have an effect of providing warmer CRAH supply air and a warmer server inlet temperature, it should result in energy savings according to Table 4.

Table 4: Energy Saving as a Result of Increasing 'Free Cooling'

Chilled Water Temp	Free Cooling Hours	Energy Saving	Cost Savings
50°F	3,600	3,960 kWh	\$ 673.00
55°F	4,300	4,730 kWh	\$ 804.00
60°F	4,950	5,445 kWh	\$ 926.00

Strategies that Work

PTS recommends several specific strategies when considering improvements or new design elements in achieving energy-efficient IT operations. These strategies include:

- **IT Systems Re-design.** There are a number of IT re-design options to reduce power consumption. Currently, the number one approach is to leverage virtualization across server and storage infrastructure.
- **Scalable Deployments.** More closely match power and cooling capacity to the actual load. The power penalty of “fixed losses” from under-loaded equipment can be significant.
- **Close-Coupled Cooling with Air Balancing and Partial Containment.** Air mixing is the enemy of effective cooling. In-row or close-coupled cooling solutions greatly reduce air mixing by closely coupling the IT equipment’s hot air discharge with the CRAC/CRAH’s hot air return and the CRAC/CRAH’s cold air supply with the IT equipment’s inlet. Additionally, close-couple CRAC/CRAH units have the capability of varying their airflow, thereby balancing their supply CFM commensurate with the CFM requirements of the IT equipment using either temperature and/or pressure as a control. Air mixing can further be reduced by implementing partial hot-aisle containment by deploying air containment curtains and/or doors at each end of each ‘hot’ aisle.
- **Raise the Data Center Temperature with Chilled Water Cooling.** ASHRAE has issued a modified recommended thermal envelop for server inlet temperature and humidity. Its recommendation for acceptable room temperature raising the average temperature in the data center from 68°F/20°C to 80.6°F/27°C and provides acceptable conditions for IT infrastructure, particularly servers, to function at acceptable levels of performance.¹

¹ ASHRAE TC-9.9 committee, www.ashrae.org.

Increasing the server inlet temperature across a spectrum of temperatures from the prior ASHRAE temperature recommendation of 68°F shows an optimum inlet temperature of approximately 78°F. At 78°F, fans for IT equipment, such as servers, will begin to spin up to respond to a demand for increased airflow. Therefore, PTS recommends 78°F as the optimal server inlet temperature range because increased server energy consumption will negate further cooling system gains. Figure 7² shows the point at which server and cooling system temperature is optimized before additional lowering of cooling system demand by raising room temperature is overcome by server power draw.

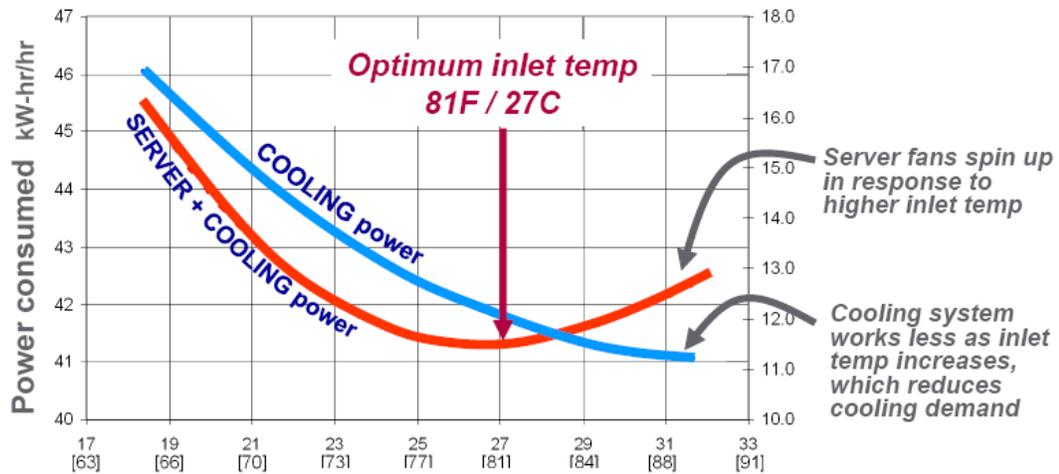


Figure 7: Optimum Server Inlet Temperature

² APC White Paper 138, Revision 1, Energy Impact of Increased Server Inlet Temperature.

About the Authors

Peter Sacco is Founder & President of PTS Data Center Solutions. Pete is a recognized expert in the areas of data center, computer room, and network operations design. His knowledge and experience cover a broad range of skills, including facility and IT-based services and solutions for mission critical environments. Throughout his fifteen-plus year career, Pete has been involved in the development of millions of square feet of data center space. Pete Sacco visits as many as fifty data centers per year to evaluate their overall availability and risks, assess their support and IT infrastructure's capacities and redundancies, and to provide recommendations for improvement.

Larry Davis is Vice President for the PTS Information Technology Solutions Group and the Director of Marketing for PTS. During the past 25 years Larry has worked in both small and large organizations and has a proven ability to analyze business strategies and develop cohesive and winning strategic business and marketing plans. His experience includes direct marketing, general management, and strategic oversight in various technology companies as well as consulting for diverse professional services, technology, and product companies. Larry holds a B.S.E.E. from Boston University, an M.S.E.E. from Columbia University, and an M.B.A. from Duke's Fuqua School of Business.

Tom Niessen is the Information Technology Services Manager at PTS Data Center Solutions. Tom is responsible for the operation and maintenance of all corporate information technology systems as well as oversight of all client-based information technology projects. Additionally, Tom acts as a senior field service engineer and is qualified to startup, maintain, and repair data center power and cooling equipment. Tom also works with PTS's consulting and design & engineering departments by providing project management services, including contractor/construction management and support infrastructure equipment commissioning, for client data center and computer room projects. Tom attended school at ComputerTraining.com in King of Prussia earning his MCSA and CCNA certifications.

Suresh Soundararaj is a Project Engineer and Computational Fluid Dynamics Specialist for PTS Facilities Technology Solutions Group. He holds a masters degree in mechanical & aerospace engineering from Syracuse University. He has diverse expertise in computational fluid dynamics (CFD) modeling, computer aided design (CAD), and HVAC systems design for computer room and data center environments. He has conducted airflow and contaminant transport analysis for a multi-zone test bed. Additionally, Suresh has implemented numerical solution of 2D Navier-Stokes Equation using SIMPLE algorithm for a steady, incompressible laminar flow, and also, simulated the effect of air cleaner in a test room.

About PTS Data Center Solutions

Experts for Your Always Available Data Center

PTS Data Center Solutions specializes in the business strategy, planning, designing, engineering, constructing, commissioning, implementing, maintaining, and managing of data center and computer room environments from both the facility and IT perspectives.

Founded in 1998, PTS is a consulting, design/engineering, and construction firm providing turnkey solutions, and offering a broad range of data center, computer room, and technical space project experience. PTS employs industry best practices in integrating proven, 'best-of-breed', critical infrastructure technologies that result in always available, scalable, redundant, fault-tolerant, manageable, and maintainable mission critical environments.

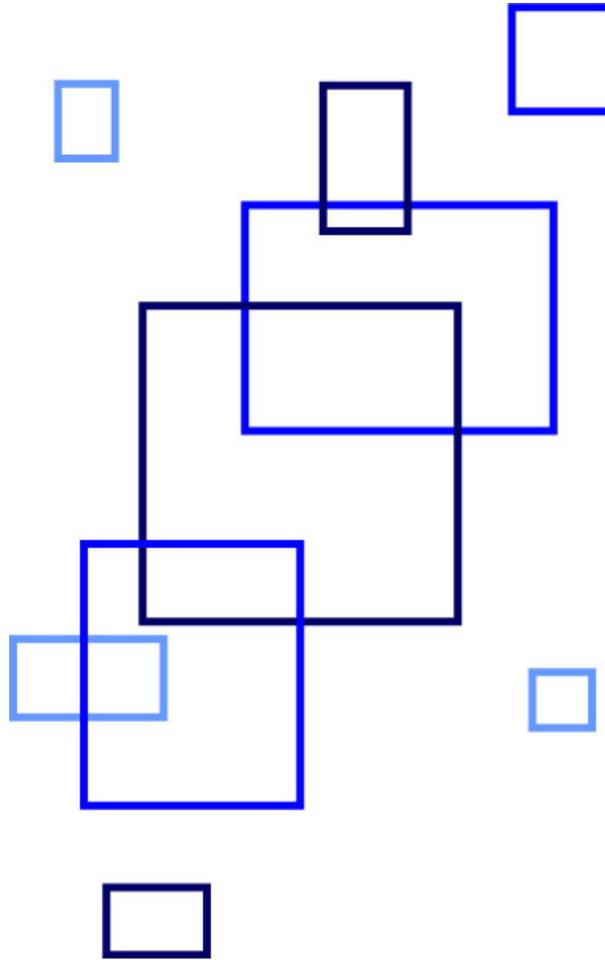
Integrated Data Center Facility and IT Expertise

With a proven process for understanding and addressing client needs as well as integrated facilities and IT experience and expertise, PTS has a unique vantage point for executing data center, computer room, and network operations center projects.

In every engagement, PTS applies a disciplined, consultative approach to systematically survey and assess the situation and then develop effective plans for seizing opportunities and overcoming obstacles. And, PTS offers a full complement of services—from business strategy and planning to facilities engineering to IT design and implementation—to help transform those plans into reality.

From our corporate headquarters in Franklin Lakes, New Jersey, and our office in Orange County, California, PTS works to fulfill our mission of creating satisfied customers by emphasizing planning and pre-construction services to provide the optimal people, process, and technology solution to meet our clients' needs and results in an early and accurate alignment between scope, schedule, and budget.

For more information, contact PTS at 1-866-PTS-DCS1 / 1-866-787-3271 or visit PTS online at www.PTSdcs.com.



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