

**IT Cost Savings Audit**  
**Information Technology Report**

Prepared for *XYZ* Inc.

November 2009

**Executive Summary**

This information technology report presents the technology audit resulting from the activities of the Zuma Engineering and Research Professional consultant service team. The purpose of the audit was to identify and quantify opportunities for energy and cost savings for the XYZ IT infrastructure. A virtualized computer architecture is provided with estimates of cost savings, power reductions and utilization improvements for the XYZ IT infrastructure. Also provided are a description of the analysis techniques and assumptions made by the IT team during the project.

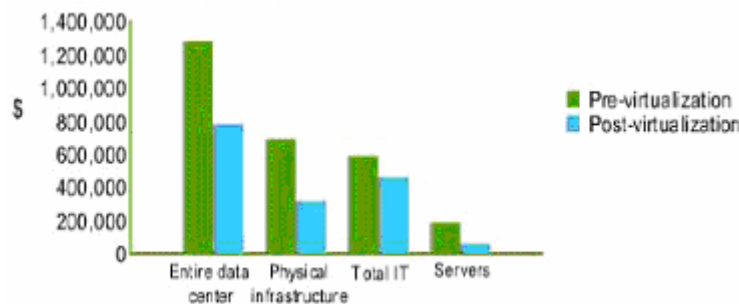
The project resulted in a number of potential changes to the existing application environment. The reduction in servers reduced the number of racks and cooling fans required by 15%. System reliability will increase due to the reductions in computer complexity and physical equipment. HA has increased since virtual servers automatically restart when a virtual server fails. The results are summarized below. The detailed analysis and system illustrations are available within the report.

**Hardware and Maintenance**

- Virtualization enabled XYZ to replace 505 physical servers with 101 virtual servers
- A 30% reduction in data center space, saving 400 square feet and \$10,000 annually.
- disaster recovery rapid, reliable, manageable, affordable
- Estimated savings of \$100,000 overall in new server costs and \$5,000 in maintenance along with salaries for 3 full time equivalent (FTE) administrators over 5 years.

**Utilization Improvements**

- A minimum of 50% shorter backup window
- Service C and Service D systems will be augmented to provide Private Agents with a user-friendly interface, and will also employ imaging technology.
- The Service E system will be provided with a dedicated and consistent user interface.



	PRE VIRTUALIZATION	POST VIRTUALIZATION	SAVINGS
Server	505	101	80%
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Total Data Center Power	1217 KW	742 KW	39%
Electric Bill	\$1279	\$779	39%

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## Introduction

### The Need for Green Computing

The increasing reliance on digital data in our society is driving a rapid increase in the number and size of data centers. This growth is the result of several factors, including growth in the use of internet media and communications, ongoing digital conversion of business applications, establishment of new regulations that require retention of digital records, and requirements related to disaster recovery. Unfortunately, this growth has contributed to Information Technology (IT) becoming a significant contributor to rising energy consumption among businesses.

A typical data center facility spends almost half of its energy consumption on the systems powering and cooling the computers inside - not on the computers themselves. The introduction of more efficient CPUs based on chip multiprocessing has contributed positively toward more energy-efficient servers. However, even an energy-efficient server still consumes about half its full power when virtually no work. In 2007 the EPA Report to Congress on Server Data Center Energy Efficiency was published in response to U.S. Congress Public Law 109-431. The report confirmed the rapid growth and energy consumption of data centers and generated new interest in **Green Computing** - the study and practice of using computing resources efficiently.

The world's data centers are projected to surpass the airline industry as a greenhouse gas polluter by 2020, according to a new study by McKinsey & Co. Over that time, the carbon dioxide emissions attributable to the electricity consumed by fast expanding data centers will rise fourfold, the study estimates.

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and

The cost of electrical energy in the U.S. is rising at an annualized rate of 11 percent, most of this feeding fossil-fuel generation. Data centers are projected to consume 2.3 percent of total electricity production in the U.S. by 2010.

Fortune 1000 companies face pressure to deliver new business applications and services at an ever increasing pace in the face of rising power and cooling costs. These applications and servers often require new hardware that utilizes additional rack spaces, thereby gobbling up precious floor space. Over the past decade the cost of power and cooling has increased 400% and is expected to continue to rise. In some cases a data center's electric bill may consume 40% to 50% of its operating

cost. As a result, data center consolidation has rapidly emerged as the number one priority for many IT managers. New technologies such as *virtualization* - the replacement of physical servers with 'virtual' (software) servers- are being employed to help. *Server Virtualization* brings the potential to deliver cost effective implementation of disaster recovery (DR), high availability servers (HA) and dramatic savings in terms of server count, footprint, power consumption and cooling requirements.

The "greening" of the data center introduces a new dimension into server consolidation and virtualization; that is, the need to factor in server power consumption and cooling requirements when planning, implementing, and managing the consolidated, virtualized environment. IT administrators must ensure that the resulting server configuration reduces power consumption, can handle current workloads at agreed-upon service levels and provide sufficient room for growth. Zuma Engineering and Research was tasked by XYZ to identify and quantify opportunities for energy and cost savings related server consolidation within the XYZ IT system. The information in this report will serve as a step toward meeting these goals by providing a snap shot of the existing infrastructure (including applications) and a server consolidation project appraisal. The results can be use as stand-alone inputs or augmented with plans for new business applications and services to generate cost-benefit analyses for XYZ.

## Audit Objectives

The following objectives were agreed upon and accomplished by the Zuma Engineering and Research professional consultants per the statement of work (SOW) shown in the appendix Catalog and document the XYZ IT infrastructure

- a. Equipment
  - b. Software
  - c. IT admin
  - d. Maintenance
  - e. Cooling System
  - f. Data Center Space
2. To assess XYZ computer power usage and determine optimal ways to reduce power consumption
  3. Assess and recommend a path to server consolidation via virtualization

## Methodology

Our assessment methodology baselined the current server architecture and measured the improvements in costs, power efficiency, physical space and infrastructure utilization for consolidation. The approach taken with this report has been shaped by the technical and business assumptions listed below and in appendix A of this test report. **Zuma Engineering and Research** employed the following analysis techniques to meet the audit objectives. The complexity of each level increases with the need for additional tools as described below.

	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Visual Inspection	X	X	X	X
Survey	X	X	X	X
Parallel Simulation		X	X	X
Electronic Equipment			X	
Generalized Audit Software				X

Level 1: Collecting data via visual inspection and surveys are conducted. Existing measurement systems are used to identify and collect data if available

Level 2: Data is collected via visual inspections, surveys and parallel simulation. Parallel simulation is a computer simulation that mimics the client's computer activity to gather statistical information for analysis.

Level 3: Data is collected via visual inspections, surveys, parallel simulation and electronic equipment. Electronic equipment is used to temporarily monitor system statistics (e.g. power, airflow).

Level 4: Data is collected via visual inspections, surveys, parallel simulation and electronic equipment. In addition, employ Generalized Audit Software (GAS) to perform tests on computer files and databases.

The following provides the method used to inventory and record the electrical and cooling operational characteristics for the XYZ IT infrastructure components

COMPONENT	LEVEL	ANALYSIS DESCRIPTION
Equipment	1	Visual inspection and calculations
Software	1	Survey
IT Admin	1	Survey
Maintenance	1	Survey
Cooling System	3	Electronic Equipment and Survey
Data Center	1	Visual Inspection

*See appendix for copy of the approved measurement plan*

## Existing Infrastructure

An information technology infrastructure is defined as the hardware, network and systems software components which provide the necessary framework for the development, implementation and administration of applications and services. This section describes the information technology infrastructure. The three subsections of this section describe the infrastructure from several different viewpoints:

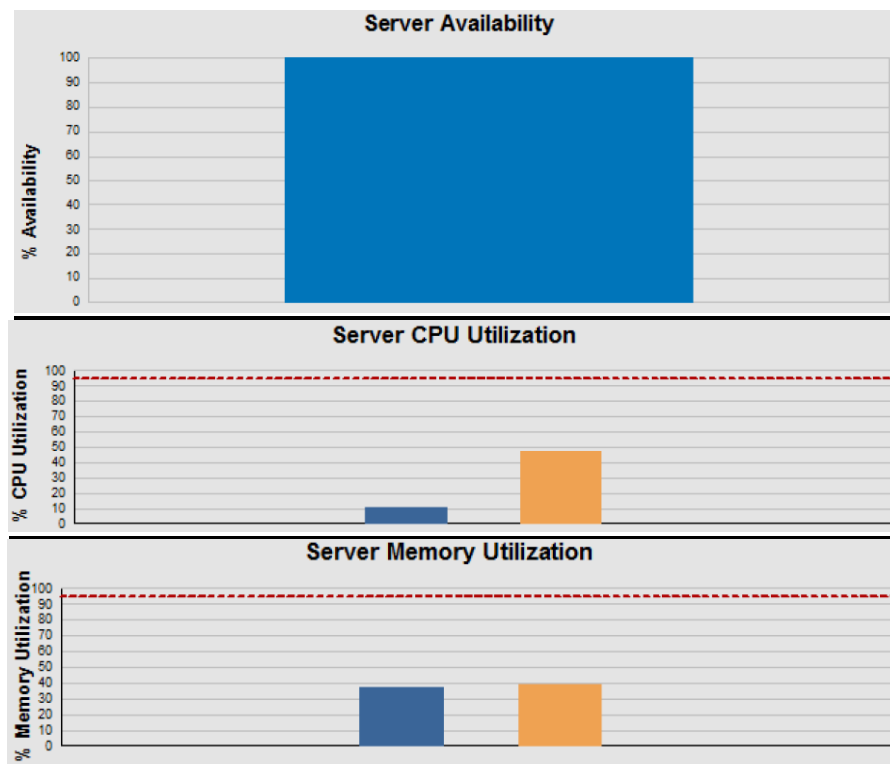
- Conceptual Overview of the Operational Network (i.e., WANs, LANs)
- Hardware (i.e. Servers, workstations, routers, etc.)
- Applications (i.e. processing, software, etc.)

*Each subsection consists of a diagram accompanied by a narrative description.*

## System Utilization

*This section discusses the server, workstation and network utilization*

### Server Utilization



### Workstation

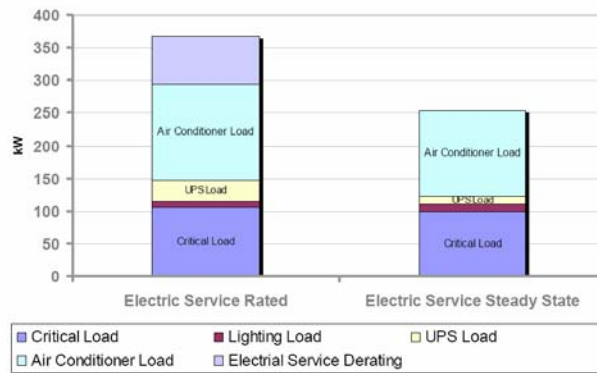
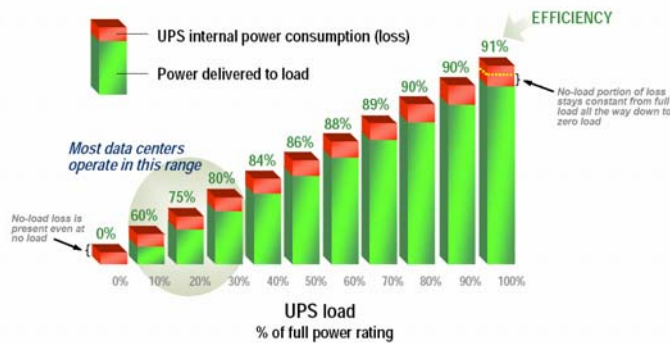
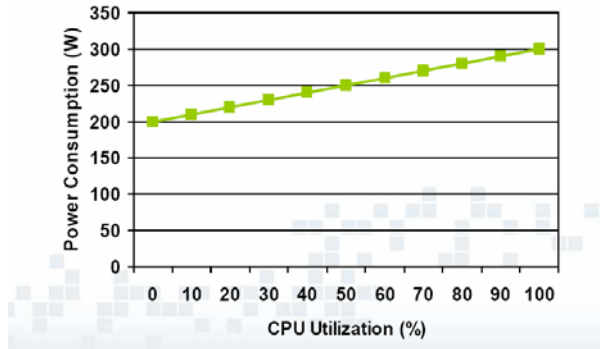
*This section discusses the current workstation utilization*

### Network Utilization

*This section discusses network utilization*

## Data Center Power Calculations

Zuma Engineering and Research created the following list of all measurements required to accurately characterize the power use of the data center infrastructure and reviewed the measurement plan with the data center operator prior to the site visit. Instrument and measure power flows on all required equipment and systems were taken without interruption of the circuits, according to the measurement plan. The results are the following.....



This is a sample report, intended to provide the customer with an example of the final report format. All data contained within is notional and should not be construed as being applicable to any particular IT infrastructure or company

## Cooling System

Routine checks of a data center's cooling system can identify potential cooling problems early. Changes in power consumption, IT refreshes and growth can change the amount of heat produced in the data center. Our consultants performed the following assessments to evaluate potential problems that can adversely affect the cooling environment within a data center.

- Capacity Check - Each Watt of IT power requires 1 Watt of cooling
- Check CRAC.
- Visual inspection of enclosures - Are there any gaps in the u positions? Are CRT monitors being used? Are blanking panels installed in these racks? Is an excess of cabling impeding the airflow?
- Check air paths below floor - Check sub-floors for cleanliness and / or obstructions
- Check aisle and floor tile arrangement - As air passes through each consecutive row the IT equipment is subjected to hotter intake air. If all the rows have the cabinets arranged so that the inlets of the servers face the same direction equipment malfunction is imminent.
- Check placement of CRAC units - The position of the CRAC units relative the aisle is important for air distribution.

Capacity Check				
CRAC	Model	Total Capacity	Sensible Capacity	Quantity
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				
Unit 6				
Unit 7				
Unit 8				
Unit 9				
Unit 10				
		<b>Total Usable Capacity = SUM (Sensible Capacity x Quantity)</b>		

Heat Load Requirement			
IT Equipment	Total IT load power in watts	Same as total IT load power in watts	
UPS with Battery	Power system rated power in watts	$(0.04 \times \text{Power system rating}) + (0.06 \times \text{Total IT load power})$	
Power Distribution	Power system rated power in watts	$(0.02 \times \text{Power system rating}) + (0.02 \times \text{Total IT load power})$	
Lighting	Floor area in square feet, or floor area in square meters	2.0 x floor area (sq ft), or 21.53 x floor area (sq m)	
People	Max # of personnel in data center	100 x Max # of personnel	
Total	Subtotals from above	Sum of heat output subtotals	
			Capacity is equal to or greater than heat output? <input type="checkbox"/> Yes <input type="checkbox"/> No

Inspecting the Rack			
Blanking Panels	Are blanking panels installed in all rack spaces where IT equipment is not installed?	Meets Tolerance (check one)	<input type="checkbox"/> Yes <input type="checkbox"/> No

Air Path Below the Floor (where applicable)			
Visible obstructions	Are blanking panels installed in all rack spaces where IT equipment is not installed?	Meets Tolerance (check one)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Missing tiles, gaps and voids	Are all floor tiles in place? Are cable access openings adequately sealed?		<input type="checkbox"/> Yes <input type="checkbox"/> No

Aisle and floor tile arrangement			
Perforated floor tile positions	Are blanking panels installed in all rack spaces where IT equipment is not installed?	Meets Tolerance (check one)	<input type="checkbox"/> Yes <input type="checkbox"/> No
CRAC positioning	Do the CRACs line up with the hot aisles?		<input type="checkbox"/> Yes <input type="checkbox"/> No
Hot aisle, cold aisle layout	Is there separation between hot and cold aisles (racks not facing the same direction)?		<input type="checkbox"/> Yes <input type="checkbox"/> No

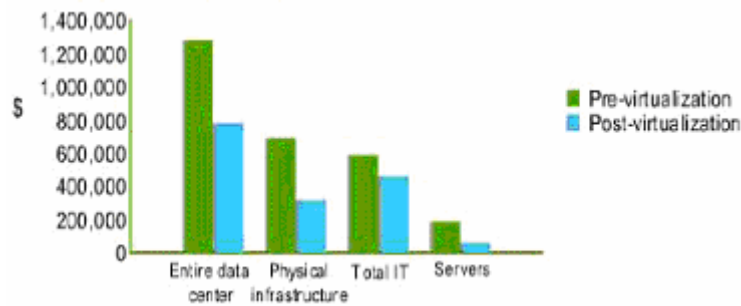
## Consolidated Server Architecture

A well designed infrastructure can be thought of in relation to a good telephone network; the users of the system neither know nor care what technology exists under the surface, as long as they can carry on their business with reasonable service levels, at an acceptable cost, and can expect new services to be rolled out without a significant new investment. The network topology below.....

*In this section: Structure defined - How it fits with user needs - Benefits (power, cost, administrative, utilization, etc)*

## Findings and Recommendation

**Pre-virtualization vs. Post Virtualization**



	<b>PRE VIRTUALIZATION</b>	<b>POST VIRTUALIZATION</b>	<b>SAVINGS</b>
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<b>Electric Bill</b>	<b>\$1279</b>	<b>\$779</b>	<b>39%</b>

Additional Data Center improvements: CRAC/CRAH adjusted; UPS/PDU optimized

## **Analysis**

*In this section: Cost benefits (ROI) - Utilization benefits- Administrative benefits*

# APPENDICES

## IT infrastructure inventory

The following is a list of major components in the IT infrastructure developed from the service questionnaire and visual inspection.

	<b>Component</b>	<b>QTY</b>	<b>Model</b>	<b>Manufacturer</b>	<b>Physical Location</b>	<b>Description</b>
<b>Servers</b>						
	<b>Unix</b>					
<b>Routers</b>						
	<b>10/100 8 port VPN</b>					
<b>Switches</b>						
<b>Power Supplies</b>						
	<b>UPS</b>					
<b>Operating Systems</b>						
	<b>Windows 2000 Professional Service Pack 4</b>					
	<b>MS Windows XP service Pack 3</b>					

# Statement of Work

## Assessment Preparation Questionnaire

The first step in identifying cost and efficiency savings is to acquire actionable data by determining the current system configuration (servers, cooling, floor spacing, etc.).

- Diagram existing infrastructure.
- Catalog existing infrastructure components
- Identify performance requirements.

## Assessment

Measurements and calculations will be performed to generate a hardware utilization report that identifies workload and resource mismatches such as under-utilized or over-utilized servers.

- Identify general data center conditions
- Baseline data center power and maintenance costs.  
Inventory and record the cooling operational characteristics of the infrastructure: air distribution systems, heat rejection systems, pumps, humidifiers, computer room air conditioners/computer room air handlers (CRAC/CRAH).
- Inventory and record the electrical operational characteristics of the infrastructure: utility input, UPS power, distribution units, static and automatic transfer switches
- Measure power per customer approved power measurement plan.
- Identify and collect utilization data using surveys and existing measurement systems.
- Compute data center efficiencies using PUE measurement metric.
- Identify all design, installation or operating practices of the data center that compromise efficiency (e.g. workload and resource mismatches such as under-utilized or over-utilized servers).

## Analysis and Report Generation

Armed with a detailed profile of workloads in the data center and analysis of real-time utilization data we will evaluate virtual solutions with different combinations of hardware and virtual hosts. Tactical solutions that make the existing system efficient will also be evaluated in this step. These include, but are not limited to enabling server processor power saving features; powering down servers when not in use; and removing old systems that provide no useful work. In addition, we will quantify the cost, physical space, and power savings for our customer.

- Determine virtualization architecture that meets requirements
- Document changes required to modify existing system
- Identify costs for design, installation and maintenance of virtualized system
- Determine projected efficiency improvements
- Perform Return On Investment (ROI) calculations
- Prepare pre-virtualization vs. post-virtualizations comparison (power, hardware, utilization)
- Provide recommendations for general data center improvement

## Analysis Assumptions & Exclusions

The approach taken with this report has been shaped by the technical and business assumptions listed below. This section spells out key assumptions and any limitations to the interpretation of the data for the analysis.

### Assumptions

Power consumptions assumptions:

- Power usage tracks CPU usage

Power calculations conducted by reputable consulting engineering firms and power supply manufacturers indicate that the nameplate rating of most IT devices is well in excess of the actual running load by a factor of at least 33%. The U.S. National Electrical Code (NEC) and similar worldwide regulatory bodies also recognize this fact and allow electrical system planners to add up nameplate data for anticipated loads and multiply by a diversity factor, Anticipating that not all devices are running at full load 100% of the time.

Cooling assumptions:

- Manufacturer recommended amount of equipment required to cool servers.
- Airflow measurement was not included in analysis; however vents were investigated for cleanliness and obstruction.

Cost assumptions:

- Server prices were based upon.....

### Exclusions

The following items are outside the scope of this service offering:

- Direct measurement of voltages above 600 VAC.
- Opening of panels with an arc-flash rating of 600 VAC or higher.
- Installation of temporary or permanent power monitoring equipment.
- Design of a more efficient data center.
- Analysis of IT, power or cooling equipment efficiency.
- Direct measurement of voltages above 600 VAC.
- Opening of panels with an arc-flash rating of 600 VAC or higher.
- Installation of temporary or permanent power monitoring equipment.
- Design of a more efficient data center below top level architecture depicted – customer should vendors for designs
- Detailed Analysis of IT, power or cooling equipment efficiency.

# **Professional Services Consultant Biographies**

# Measurement Plan

The following agreed upon measurements were observed

Component	Parameter	Value	Comments

This section describes the instrumentation and tools that were used during the analysis.

- **Digital Anemometer** - used to determine airflow through vents and rack grilles.
- **Digital Thermometer** – used to measure room and rack temperature to determine CRAC (computer room air conditioner ) requirements
- **Power meter** - temporary power monitoring equipment

# **Diagrams and Illustrations**