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Strategic Snapshot

Improving Energy Efficiency through Application Infrastructure Virtualization:
Introducing IBM WebSphere Virtual Enterprise

By

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ABSTRACT

While those "in the know" have always been aware of cooling and power distribution limitations, until recent years most organizations have not been affected by those physical limits. Facilities personnel used to address power and cooling needs without much notice, but the increasing demand from IT equipment has made the facilities a constraint to IT and business growth.

Today, in many organizations' data centers, power, cooling, and floor space have become significant inhibitors to growth while energy costs are consuming an increasingly high proportion of the overall operational budget. Concurrently, to help meet the rising demand for IT services, many organizations have made Service Oriented Architecture (SOA) the underpinning for their enterprise application strategy. Not surprisingly, IT administration has become the leading IT cost and as with energy consumption, is increasing at an alarming rate.

Given these growing costs, the major IT vendors have begun promoting "green IT" technologies that are designed to be more energy efficient and less harmful to the environment. While the discussion around green IT has been largely framed as an environmental issue, it is also focused on increasing efficiency and utilization. Reducing the consumption of key resources such as energy and personnel while improving the utilization of IT hardware and software can yield environmental (green) benefits as well as financial (green) benefits.

Virtualization is one means by which organizations can improve the efficiency of the data center and utilization rates for IT resources. Virtualization can also assist organizations in reducing their expenditures for energy. As various components of IT have been added to the virtualization fold, there have been new opportunities for organizations to improve their utilization and energy efficiency.

In this paper, we examine the ways in which Application Infrastructure Virtualization allows the infrastructure to dynamically adapt and respond to business needs, and provide for requests to be prioritized and intelligently routed to respond to the most critical applications and users. With WebSphere Virtual Enterprise, IBM has positioned itself to meet the current and ever-increasing "green" needs of the marketplace providing benefits both environmental and financial to enterprises of most any size.

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TABLE OF CONTENTS

Challenges in the Data Center

In the future, we may view the first decade of the 21st century as the time that power consumption, cooling, and energy efficiency in the data center ceased being a back-burner issue and elevated itself to the forefront. While those "in the know" have always been aware of cooling and power distribution limitations, until recent years most organizations have not been affected by those physical limits. Today, many organizations are increasingly challenged by the lack of adequate power and cooling infrastructure in their facilities, inability to deploy modern dense computing environments, data center space constraints, and the increasing cost of energy to support their business applications. Not surprisingly, IT management and administration have become the leading IT costs and are increasing at an alarming rate : an estimated 400% increase from 1996 costs to 2010 projections.[1]

This challenge is not just limited to large data centers, but is also affecting IT facilities of more modest scale. Although much of the cost-cutting by CIOs and CFOs during the first part of this decade have focused on infrastructure consolidation and headcount reductions, it did not take too long for the impact of $100+/bbl oil and rising electricity costs to affect the data center. At the same time, rather ironically, all the focus on server and storage consolidation combined with denser form factors such as blades has changed the heat-generation and dissipation characteristics of the data center. Attempts to cool, or more aptly, overcool the data center to compensate for these new thermal dynamics has resulted in energy costs becoming the fastest-growing IT expense, with 2010 estimates an 800% increase over 1996 costs.[2] In 2006, for each $1 in server purchase expense, $0.52 was spent on power and cooling. This is projected to grow by 37% to $0.71 in the year 2010.[3] Cooling design capacity is being outstripped by new higher-density IT solutions, current draw is increasing, and capacity constraints by either the utility or data center design are limiting future power consumption growth.

Green IT and the Role of Virtualization

Given the growing costs associated with energy usage in the data center, the major IT vendors have begun promoting "green IT" technologies that are designed to be more energy-efficient and by extension less harmful to the environment. While the discussion around green IT has been largely framed as an environmental issue, it also focuses on increased efficiency and utilization. Reducing the consumption of key resources such as energy and personnel while improving the utilization of IT hardware and software can yield environmental (green) benefits as well as financial (green) benefits. In other words, green IT is a matter of using all resources as efficiently as possible, i.e., not wasting any of them.

Improved Utilization and Energy Efficiency

Virtualization is one means by which organizations can improve the efficiency of the data center and utilization rates for IT resources. Virtualization can help organizations reduce or postpone capital outlays for equipment and the associated human resources to manage it. Improved ROI can be achieved through the increased utilization of existing resources as well as the corresponding reduction in installation and operations expense for new hardware. The simplification of the IT infrastructure also minimizes the headcount required for its operation, which in turn can permit reassignment of some IT professionals to activities that target the growth of the business, not just its ongoing operation.

Further, virtualization can assist organizations in reducing their expenditures for energy, as fewer pieces of hardware are required to support a given workload. If the equipment is refreshed to state-of-the-art offerings, the potential for improved energy efficiency is even

greater. This is due not only to the improved computational performance of new systems but also to their increased performance per watt of energy consumed. The reduced watts per workload also results in reduced cooling demands as less heat is generated.

Enhanced Business Performance

The flexibility to dynamically provision resources allows organizations to align IT resources according to business requirements. IT no longer has to be siloed by workload or department with the inherent underutilization and instead can be deployed on a shared basis across a smaller collection of hardware. This consolidation offers the potential to redeploy some operations and maintenance-focused personnel to tasks focused on innovation in business models and processes. Virtualization can enhance application service quality as it provides a cost-effective infrastructure on which to support enterprise applications and SOA. SOA, while not a requirement to deploy enterprise applications or virtualization, does offer a strategic approach to delivering applications and services throughout the enterprise.

IT Optimization

IT optimization and virtualization yields increased energy and financial efficiency through improved utilization of existing resources as well as reduction in human resource costs, capital spending, and energy consumption. Virtualization is not limited just to the data center as it includes user clients (desktops, laptops, thin clients, etc.) as well. Client virtualization can be viewed in two segments:

- Desktop hardware and operating system virtualization
- Application virtualization

Data center virtualization affects a larger number and variety of resources and can be viewed in four segments:

- Server hardware and operating system virtualization
- Storage virtualization including SANs and network file systems
- Network virtualization including virtual and pooled I/O
- Application Infrastructure Virtualization (a new category)

Expanding Virtualization in the Data Center: Application Infrastructure Virtualization

The days where virtualization simply meant partitioning a server to support multiple applications or operating systems are long gone. As various components of IT have been added to the virtualization fold, there have been new opportunities for organizations to improve their utilization and energy efficiency. With this in mind, we see a new aspect of virtualization coming into its own, namely, Application Infrastructure Virtualization (AIV).

Definition

AIV provides the ability to separate the applications from the underlying infrastructure that they run on. Workloads are dynamically placed and migrated across a pool of application server resources that allow the infrastructure to dynamically adapt and respond to business needs, and provide for requests to be prioritized and intelligently routed to respond to the most critical applications and users.

Impact

This loose coupling enables open standards-based software to intelligently manage and shift workloads according to agreed-upon business policy. For instance, high-priority applications can be allocated to the majority of resources whereas lower-priority applications are shifted to lower-performance/less-costly resources or designated to run later. Any prioritization operations are performed in a seamless fashion that creates minimal impact for the end user. AIV increases applications availability and performance as well as offering cost improvements in both operational and energy expense.

IBM WebSphere Virtual Enterprise

The four aspects of data center virtualization discussed earlier are complementary and required for an organization to achieve a truly virtualized data center. Server, Storage, and Network virtualization have been a growing part of the IT landscape during the past few years. As such, IBM has been providing solutions that focus on these key IT enablers. With the emergence of AIV, IBM has developed a new offering for organizations seeking to undertake AIV to reduce the costs associated with energy, management, and the ongoing operations of their IT investments: IBM WebSphere Virtual Enterprise.

IBM WebSphere Virtual Enterprise complements existing server, storage, and networking virtualization by bringing the same degree of flexibility and prioritization to the applications that are using these pooled application server resources. WebSphere Virtual Enterprise provides functionality that is analogous to a server hypervisor but with a focus on application servers.

This latest virtualization technology is another example of IBM's continued commitment to improving energy efficiency in the data center as part of the company's vision for the New Enterprise Data Center. WebSphere Virtual Enterprise provides a superior application deployment environment by matching available IT resources to workload demands with new virtualization services at the application layer. Through its flexibility in managing resources, prioritization of applications according to business rules, and the corresponding reduction in energy consumption afforded by its pooled resource approach, it plays a key role in expanding the scope of virtualization and provides organizations another means to improve their data center utilization and energy efficiency. For organizations that have taken an SOA approach for delivery of their enterprise applications, WebSphere Virtual Enterprise is a complementary addition to the IT infrastructure that further enhances application and services delivery while improving flexibility, cost-effectiveness, and energy consumed per workload supported.

WebSphere Virtual Enterprise and Energy Efficiency

WebSphere Virtual Enterprise enables organizations to take their virtualization initiatives to the next level of efficiency. The two primary direct financial benefits from deploying WebSphere Virtual Enterprise are the reductions in energy and personnel costs associated with operating the application server infrastructure. Through the deployment of server virtualization and AIV, most organizations can achieve a marked increased in utilization of existing hardware and software resources, and related IT investments. By increasing utilization, organizations can deploy additional workloads with only an incremental increase in server management and administration expense. If server consolidation is undertaken as well, some administrative resources can be redirected to other activities and budget categories.

By reducing the number of servers that support a set of applications and services, the energy required can be diminished correspondingly. The energy savings come not only from having fewer servers, network switches, etc., but also from reduced demand for cooling to offset the heat generated by IT equipment. In general, the energy required to cool is at parity with the energy that generated the heat. If 1000W in equipment power draw is removed, then approximately 1000W in cooling is saved as well. With server racks and blade enclosures drawing tens of kilowatts each, the combined energy savings can be substantial. Since energy cost is now recognized as the fastest growing IT expense—and is on its way to become the second largest IT expense[4]—the financial impact on the bottom line is considerable.

In addition to immediate energy and administrative savings achieved through increased utilization of resources, capital spending for new hardware and software otherwise required to support continued growth can be delayed. Not only does this delay improve operating margins as capital is preserved, but new administrative and energy expenses are avoided as well.

Quantifying the Benefit of WebSphere Virtual Enterprise

For many IT professionals the operational benefits from AIV may seem obvious; however, from a business perspective it is important to build a solid operational assessment and financial case to support these perceptions. In order to meet this need, IBM has created a TCO tool, known as the Business Value Assessment.

This assessment quantifies not only the technological benefits of deploying WebSphere Virtual Enterprise within the organization but the financial benefits as well. Client TCO data is captured in a multi-year cost model that compares the organization's current application server environment with that of an envisioned WebSphere Virtual Enterprise-enabled environment. The cost data includes IT expenses related to both implementation and operations.

The Business Value Assessment is a five-step process that consists of the following:

1. Customer objectives and scope are verified and clarified before data collection begins.
2. Data is collected against the customer's current server environment.
3. Data is validated and is examined to search for and refine potential benefits.
4. Customer investment costs are identified and captured for reference.
5. TCO model is assembled and the business case is developed.

After the assessment is complete, the customer receives a copy of the customer-specific TCO model, presentation of the business case for WebSphere Virtual Enterprise deployment, and the solution architecture for transforming their existing infrastructure into an AIV environment.

Based on a number of Business Value Assessments done with leading organizations, the cost savings achieved by deploying WebSphere Virtual Enterprise can be substantial. Here are some typical areas where savings can be expected:

- Hardware cost savings of 25–40%[5]
- Energy cost savings of 25–40%[6]
- Administrative operational cost savings of 35–55%[7]
- Planned maintenance cost savings of 45– 55%[8]
- Reduction in unplanned outages of up to 98% and achieving 99.999% uptime[9]

IBM's Energy Efficiency Vision in Action

IBM has long recognized the importance of energy efficiency and its impact on the data center and organizations overall. The opportunity for green IT is considerable as the magnitude of energy-intensive IT continues to grow thus increasing the importance of addressing inefficiency from energy, human, and capital perspectives. Since data centers consume 10 to 100 times more energy per square foot than a typical office building, improving their efficiency could have a substantial impact on electricity supply and distribution especially in certain metropolitan regions.

Considering that data centers consumed approximately 180 billion kWh in 2005 and only 45% of energy consumed was powering the servers, storage, and networking hardware[10], the potential for reducing overall energy consumption related to IT is sizeable. A 20% efficiency improvement could save 36 billion kWh and 22 million tons of CO_2: the equivalent of removing 4.2 million passenger cars from roadways.[11]

IBM Project Big Green: One Year Later

On May 10, 2007, IBM announced Project Big Green, articulating IBM's vision for green data centers that are significantly more energy-efficient than their predecessors and feature up to 40% reduction in power and cooling, 20% increase in server and storage utilization, and floor space reductions upwards of 80%.[12]

As initially announced, through its Project Big Green initiative, IBM is focused on five key steps towards improving energy efficiency:

- Diagnose: energy assessment, virtual 3-D power management, and thermal analytics;
- Build: plan, build, or update to an energy-efficient data center;
- Virtualize: IT infrastructures and special-purpose processors;
- Manage: control with power management software; and
- Cool: exploit liquid cooling solutions inside and out of the data center.

As part of the Project Big Green announcement, IBM committed to doubling its peak capacity without increasing its energy consumption or environmental impact. This is envisioned to result in a cost avoidance of 5 billion kWh annually, which is an equivalent carbon abatement of taking about 500,000 automobiles off the road.[13] IBM identified 3900 UNIX and x86 servers out of its pool of approximately 10,000 that it will consolidate onto thirty-three mainframe systems. This server consolidation project is estimated to save $25 million in energy costs as part of a $250 million overall IT savings during five years.

This effort and the resulting energy savings is reflective of IBM's recently announced New Enterprise Data Center architecture, a design for customer data centers architectures in the future. However, it is important to remember the importance of applications in the grand scheme of the data center. The efficiency of the data center is multifaceted and focusing solely on hardware can result in overlooking important aspects in deploying applications in a cost-effective and efficient fashion as afforded by AIV.

IBM's vision positions IT for efficient delivery against the converging issues of technology advancements, infrastructure complexity, and rising energy costs. Efficient data centers (physical consolidation, virtualization of systems and information silos, optimized systems, innovative cooling and cabling solutions, and energy management) are entry points to this New Enterprise Data Center architecture.

Summary

Virtualization is all about IT optimization across the organization, yielding increased energy and financial efficiency through improved utilization of existing resources as well as providing reductions in human resource costs, capital spending, and energy consumption. For organizations seeking to realize these cost savings, there is a new component of data center virtualization known as Application Infrastructure Virtualization. This new virtualization category provides the ability to separate the underlying infrastructure from the applications that run on it.

AIV frees the enterprise from a tight coupling between applications and associated application servers to enable open standards-based software to intelligently manage and shift workloads according to business policy. AIV increases applications availability and performance as well as offering cost improvements in both operational and energy expense.

Energy efficiency is a growing concern not only for IT professionals but for corporate executives as well. Competitive pressures in all industries buttress the need for optimized operations and maximizing the ROI achieved on all capital expenditure. For organizations to achieve peak efficiency, they must not only understand all of the operational issues and expenses, but also have a vision that articulates their business and IT operation goals. The same holds true for vendors and business partners with whom the organization engages.

IBM has developed an AIV offering, IBM WebSphere Virtual Enterprise, to assist organizations in implementing AIV to reduce the costs associated with energy, management, and IT operations. IBM WebSphere Virtual Enterprise complements existing server virtualization investments by bringing the same degree of flexibility and prioritization to the business applications that are using the virtualized resources.

IBM WebSphere Virtual Enterprise is the latest in a family of solutions and services from IBM that target improving energy efficiency in the data center and is well positioned to become a leading component in data center virtualization, green IT, and the New Enterprise Data Center. IBM has a unique capability in WebSphere Virtual Enterprise that can help organizations meet their data center virtualization strategies as well as delivering enhanced energy efficiency, increased alignment with business priorities, and decreased operational expense. Organizations that have undertaken virtualization and energy efficiency strategies are well advised to consider the role of AIV in their data center and the potential benefits afforded by IBM WebSphere Virtual Enterprise.

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[1] *Worldwide Server Power and Cooling Expense 2006-2010*, IDC #203598, Sept. 2006

[2] ibid

[3] ibid

[4] ibid

[5] Hardware cost savings due to server consolidation with target utilization ranging from 40% to 60%. *IBM Business Value Assessments (2005–2007)*

[6] Energy cost savings linked to the hardware cost savings. Savings range could vary based upon cost per kWh. Additionally, the energy savings would depend upon various factors including specific server power consumption ratings and that kWh costs vary by geography. *IBM Business Value Assessments (2005–2007)*

[7] Administrative savings can vary greatly depending upon how an organization wants to view admin Full Time Equivalent related reductions, i.e. workforce reduction vs. re-purpose vs. cost avoidance of future hire. *IBM Business Value Assessments (2005–2007)*

[8] Planned maintenance cost savings derived using planned outages/maintenance estimated @ 8hrs/qtr/server = 32 hrs/year/server. Calculation uses 75% of server pool and a conservative cost savings benefit @ 50% of using WebSphere Virtual Enterprise. *IBM Business Value Assessments (2005–2007)*

[9] When using the average availability for the "as-is" (99.95%) contrasted with using WebSphere Virtual Enterprise at 99.999% uptime. This translates to going from 263 minutes of unplanned outages annually to 5 minutes annually. *IBM Business Value Assessments (2005–2007)*

[10] *Creating Energy-Efficient Data Centers*, U. S. Department of Energy, May 18, 2007

[11] www.epa.gov/cleanenergy/energy-resources/calculator.html

[12] *A Focus on Energy Efficiency in the Data Center-Deep Dive*, IBM presentation

[13] www.epa.gov/cleanenergy/energy-resources/calculator.html

Further Reading

Readers may wish to visit the following additional resources that are related to Application Infrastructure Virtualization, WebSphere Virtual Enterprise, and energy efficiency in the data center.

The IBM WebSphere Virtual Enterprise home page may be found at: http://ibm.com/software/webservers/appserv/extend/virtualenterprise

The IBM energy efficiency website, which contains information about the New Enterprise Data Center, as well as other IBM energy efficiency initiatives may be found at: http://ibm.com/systems/greendatacenter