EDISON Group

89 Fifth Avenue, 7th Floor
New York, NY 10003
www.TheEdison.com
212.367.7400

White Paper

IBM System x

Superiority of the IBM eX5 Systems for Virtualized SAP Environments

Printed in the United States of America

First Publication:January 2011
Produced by: Craig Norris, Lead Analyst; Howard M. Cohen, Senior Analyst; Barry Cohen

Table of Contents

Executive Summary

Today's SAP landscapes feature a growing number of applications that each run on a dedicated server. Managing these multiple-system landscapes has arguably become the largest and fastest-growing cost component in IT. Server consolidation by virtualization is playing a major role in driving improvements in SAP landscapes, such as higher server utilization, reduced maintenance costs, easier administration, greater agility, and faster responsiveness to changing business demands.

IBM leads the industry in developing x86 server technology designed to maximize the advantages data centers derive from virtualization. Its cutting-edge System x® servers enable vastly more Virtual Machine (VM) consolidation than was possible only a few years ago or is being offered by comparable competitors. The fifth generation of its enterprise X-Architecture™ systems, eX5, represents the culmination of four previous generations of leadership architecture in the x86 marketplace. IBM eX5 systems have set records for two-, four-, and eight-socket SAP benchmarks. [1]

By deploying these servers in virtualized SAP environments, organizations can consolidate their SAP landscapes to a considerable degree with no adverse effect on performance, even running extremely efficient two-tier systems with SAP applications and database all on a single powerful server. To validate this, the IBM SAP International Competence Center implemented a Proof-of-Concept (PoC) scenario designed to demonstrate this ability within realistic operating parameters rather than through outer-limit benchmarking.

The PoC involved consolidation of VMs from two of the highest-capacity quad-core servers available in previous generations, running multifarious SAP workloads at near capacity into a single eX5 server, thus achieving unprecedented VM consolidation.

The SAP VMs were successfully moved from the two currently installed four-socket x86 servers to a next-generation IBM system x3850 X5 without powering down the systems and with no downtime of SAP processes running in the environment. Overall results showed the workload ran three times faster on the SAP systems that were migrated. These very significant SAP workloads operated on the x3850 X5 with an overall load of below 50 percent CPU utilization and just 28 percent utilization of available memory.

[1] The IBM x3690 X5 holds the two-socket record; the x3850 X5 set the new four-socket record when it was announced, and shortly before this writing the four-socket BladeCenter HX5 achieved the new leading result; and the x3850 X5 still holds the eight-socket record.

Introduction

Objective

This white paper provides a brief summation of a Proof-of-Concept engagement, conducted at the IBM SAP International Competence Center, in which virtualized SAP applications and realistic workloads were migrated from two industry-leading x86 servers running at near capacity onto a single IBM system x3850 X5 server, demonstrating three times the VM capacity while operating within extremely comfortable utilization parameters. While the study itself had multiple purposes, the objective of this white paper is to show that IBM eX5 x86 platforms are capable of unprecedented VM density in consolidated x86 server environments, running an SAP application landscape consisting of CRP, Business Warehouse (BW) Enterprise Portal, and Process Integration (PI).

Audience

Any IT manager, CIO, systems architect, etc., who is considering an x86-based Windows or Linux infrastructure to run enterprise-scale ERP applications in a virtualized environment will benefit from reading this study. Anyone currently running such an operation with unacceptable constraints will also find valuable information herein, which may lead to discovery of an effective solution.

Contents of this Report

- **Virtualization in the SAP Environment** — This section discusses the major role that server virtualization and consolidation is playing in driving improvements in SAP landscapes.
- **The Superiority of IBM eX5 Servers for High-End Virtualization** — This section introduces the IBM eX5 family of servers and describes the advantages these servers offer to the virtualized SAP landscape.
- **Proof of Concept: Unprecedented Consolidation** — This section describes a Proof-of-Concept series designed by the IBM SAP International Competence Center that demonstrated, among other things, unprecedented consolidation of SAP VMs by migrating the workload of two near-capacity industry-leading servers to the next-generation IBM system x3850 X5.
- **Conclusion** — This summarizes the conclusions from the Proof-of-Concept results.

Virtualization in the SAP Environment

In the last decade, SAP landscapes have been growing and becoming more and more complex. Compared to SAP landscapes in 2001, today's SAP landscapes feature a growing number of applications that each run on a dedicated server. Managing these multiple-system landscapes entail tremendous administrative effort. Systems management is often the largest and fastest growing IT cost component when landscapes and infrastructure become more complex. Virtualization is playing a major role in driving improvements in these SAP landscapes. Therefore, servers integrating features that enhance virtualization capabilities offer significant benefits to organizations using SAP business applications.

Virtualized SAP landscapes deliver the benefits of:

- **Higher server utilization.** An organization's SAP system landscape can easily grow to numerous physical SAP system servers. SAP systems are normally sized for the capacity that is required to handle the critical peak workload, which often occurs during only a small part of the system's day, month, or even year. Consolidating a number of dedicated servers into a virtualized environment, each running at an average low rate of usage with periodic peaks, an organization can achieve a reduction of physical servers that results in less cost and reduced complexity.
- **Reduced maintenance costs.** Virtual machines can be duplicated easily, as they are basically represented by a set of files. Logistically, [2] it takes only minutes for a new virtual server to be up and running, which is a big time-saver, compared to what it takes to deploy a physical server. Rapid provisioning helps in quick setup of additional SAP application servers to increase the capacity of SAP systems by scaling out, and enables providing sandbox SAP systems for testing or education, on demand within minutes, rather than days.
- **Easier administration of the complete SAP landscape.** Virtualization facilitates monitoring and managing consolidated SAP applications, and viewing the entire SAP landscape from a single point of administration.
- **Agility and faster responsiveness to changing business demands.** The ability to load-shift virtualized SAP systems seamlessly between physical servers enables data centers to move applications between servers. This facilitates moving an application that needs increased resources on a periodic basis, such as a quarterly high-load batch run, to a higher-end server for that task, while keeping it on a less powerful server the rest of the time.

[2] Changing the System Identification Number in an actual production environment could involve additional time.

In addition, virtualization technology helps improve the reliability, availability, and serviceability (RAS) features of a server. Organizations can employ virtualization within SAP landscapes to:

- Consolidate multiple SAP instances, or the application server and DBMS of three-tier landscapes, into a single server.
- Enable higher levels of business continuity and disaster recovery via high availability (HA), minimized downtime, and reduced hardware maintenance. All virtualized SAP systems can be moved to other available physical servers in order to shut down the first server for maintenance. In the event that a physical server fails, a virtualized SAP system can be brought up again on a new server quickly.
- Establish a dynamic data center environment where IT staff can repurpose a server or VM quickly and easily.

As virtualization has become more mainstream, many customers have discovered that their current x86 server architecture is challenged to deliver optimal performance for demanding workloads such as SAP applications. To achieve desired levels of ROI from virtualization, customers are demanding better and more powerful x86 servers.

The Superiority of IBM eX5 Servers for High-End Virtualization

With the fifth generation of enterprise X-Architecture, eX5, IBM has introduced technology that represents the culmination of four previous generations of leadership architecture in the x86 marketplace. With eX5, IBM continues to leverage its extensive technology development heritage, delivering new server technology with superior memory addressability that can reduce the number of servers required for a given workload by 50-66 percent, and lower licensing fees by half with the same number of more powerful CPUs. IBM eX5 is the only x86 platform that delivers the memory technology and I/O flexibility required for breakthrough virtualization agility, with such factors as:

- FlexNode partitioning, designed to maximize system flexibility and to provide organizations the means to configure or reconfigure systems according to specific business or workload needs. Using systems management, a two-socket HX5 server can be seamlessly coupled with a second like system using Intel QPI to double its size, also doubling its processors, memory, and I/O capabilities. Servers are scalable up to 32 cores.
- Fifty percent more addressable memory than any other four-socket x86 system, made possible by the addition of the MAX5 memory expansion chassis, a breakthrough innovation that decouples memory from processors to enable memory scalability independent of additional processor outlays.
- Unprecedented x86 performance with more than triple the SAP performance improvement over previous-generation systems, demonstrated in industry-standard benchmarks, enabling organizations to support up to three times the number of SAP users per server. This in turn translates to a third of the virtualization software licenses required, reduced power consumption, and a third of the physical machines requiring floor space, upkeep, and maintenance, as well as simplifying management of the entire operating environment.
- Intel Xeon 7500 series (Nehalem-EX) processor architecture, which helps enable IBM eX5 systems to blend the ultimate x86 compute power with increased memory bandwidth and support for considerably greater memory capacity, leveraging performance superior to what was available in previous-generation processors. Memory is one of the most significant roadblocks limiting high-density VM consolidation. The 7500 series also gives eX5 systems more processor RAS features with less impact to memory performance.
- IBM eX5 eXFlash storage, based on solid-state drives (SSDs), can be integrated in order to maximize storage performance, reliability, and rack space, while

minimizing power consumption. eXFlash dramatically improves I/O performance with greater storage density and better reliability. Its unique, next-generation flash storage technology can slash storage costs up to 97 percent by replacing hundreds of hard disk drives and thousands of wires and cables. In comparison with traditional hard disk drive (HDD) storage solutions, eXFlash storage delivers 99 percent greater IOPS performance per watt for database-type workloads running on local disks, while maximizing uptime with 64 times better reliability.

Performance is essential with multiple, often business-critical, workloads running on the same server, but reliability and availability become even more essential than ever. IBM System x servers shield an organization from IT disaster with multiple levels of protection. As the latest offerings in the IBM System x technology roadmap, eX5 servers deliver advanced reliability and availability technologies to better support business-critical workloads with advantages such as:

- **IBM Predictive Failure Analysis** — Using advanced heuristic techniques and self-diagnostics, IBM Predictive Failure Analysis (PFA) helps detect when components are operating outside of normal thresholds. PFA can predict the failure of supported components, so administrators can replace them before they fail. Many vendors offer PFA on hard drives and memory; however, IBM eX5 systems feature more components, such as hard drives and solid-state drives, memory, processors, power supplies, fans, PCIe slots, and voltage regulator modules.
- **Light Path Diagnostics** — This feature potentially saves hours of troubleshooting by constantly monitoring selected components within a System x server. A failure detected by PFA causes a light to illuminate on the front face of the server to alert administrators to a problem. The pop-out/drop-down light path diagnostics panel has a light identifying the failed subsystem. Within the system, a lighted LED directs engineers or administrators directly to the failed component, saving the service engineer from having to test multiple components to find the failed (or failing) one.
- **Virtual Fabric for IBM System x** — This is a fast, flexible, reliable I/O solution that helps reduce cost and complexity in both virtualized and non-virtualized environments. It decouples I/O adapters from the server hardware that uses them to enable multiple virtual Ethernet ports from a single physical port, and allows an exact number of ports needed (from two to eight per adapter) to be defined. It also enhances reliability with Intelligent Failure Monitoring to enable automatic failover between physical or virtual ports. This technology allows many VMs to efficiently share small numbers of high-bandwidth adapters. It can reduce hardware expenditures required to adequately provision networking ports, as well as the cabling and power costs to support additional hardware. When used with a 10 Gb Virtual Fabric Adapter, one adapter can act as multiple Ethernet, Fibre Channel,

FCoE, and iSCSI adapters simultaneously, with bandwidth apportioned among them in 10 Mb to 100 Mb increments.

- **Redundant Power and I/O** — All eX5 servers feature redundant power to enable high availability for business-critical workloads. Additionally, all BladeCenter servers, including the HX5, feature redundant I/O connections as well.
- **Multiple layers of memory protection** — Because mission-critical workloads require mission-critical hardware, IBM provides all eX5 servers with several redundant levels of memory protection, from memory scrubbing to IBM Chipkill™ memory correction, to IBM Memory ProteXion,™ to memory rank sparing, to mirroring. These technologies work together to minimize downtime.
- **Improved Service** — eX5 servers offer simplified administration with consolidated, single-point management, enabling data centers to get greater productivity out of fewer systems and software licenses.

IBM's Suitability to Virtualized SAP Environments

While SAP landscapes are becoming more complex, the computing power, reliability, and management capabilities of IBM's latest eX5 Systems are also improving. SAP and IBM have worked closely on many levels, from joint product development and customer support to providing turnkey solutions to customers. The IBM eX5® family of products is designed to meet the growing computing demands of the SAP system landscape with unequalled price and performance. Simplification of deployment and maintenance allows SAP customers to focus on their implementation and to better manage their infrastructure costs.

System x servers are ideal for SAP customers who are looking for reliability, manageability, and scalability with the flexibility to run Windows or Linux. In addition to the proven and flexible virtualization capabilities of its x86 hardware, IBM also provides:

- The most extensive experience in virtualization technologies, going as far back as the 1960s to the origin of virtualization itself.
- Deep SAP technology understanding and many years' experience with virtualization of SAP environments on many platforms.
- The right tools to manage different virtualization solutions and support consolidation for all IBM platforms.

Proof of Concept: Unprecedented Consolidation

IBM eX5 systems have set records for two-, four-, and eight-socket SAP benchmarks. The IBM x3690 X5 holds the two-socket record, the x3850 X5 set the new four-socket record when it was first announced, the four-socket BladeCenter HX5 achieved the new leading result shortly before this writing, and the x3850 X5 holds the eight-socket record. [3]

Published industry benchmarks are one way to assess the top-end capability of products and/or solutions. However, benchmark configurations are most often designed to test the outer limits of specific metrics, such as performance speed, throughput, capacity, etc. They do not accurately reflect the x86 environments likely to be in place running an organization's production or test ERP workloads. When it comes to data center VM consolidation via virtualization, much skepticism persists about the ability of the x86 platform to adequately consolidate various SAP workloads with different workload characteristics on a single host.

The IBM SAP International Competence Center implemented a Proof-of-Concept scenario designed to demonstrate this ability within realistic operating parameters. [4] The PoC involved consolidation of VMs from two of the highest-capacity quad-core servers available in previous generations running multifarious SAP workloads at close to capacity into a single eX5 server, thus achieving unprecedented VM consolidation.

Application / Workload

The servers initially running the SAP application VMs were previously two of the industry's leading quad-core x86 systems.

[3] Benchmarks fully complies with the SAP Benchmark Council regulations and have been audited and certified by SAP , as follows:
x3850 X5 four-socket: SAP Certification number: 2010012 — 57,120 SAPS
x3850 X5 eight-socket SAP Certification number: 2010044 — 108,270 SAPS
HX5 four-socket SAP Certification number: 2010051 — 57,330 SAPS
x3690 X5 two-socket SAP Certification number: 2010043 — 29,300 SAPS
Details can be obtained from IBM and SAP. www.sap.com/benchmark

[4] Full implementation, configuration, and results of this PoC engagement are described in the IBM White Paper entitled *Virtualization of Two Tier SAP Systems on IBM eX5 Systems*, August 13, 2010. Also refer to *SAP Implementation and Operation in Integrated Environments*
http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP101749

The two previous systems were each identically equipped as follows:

- 2 x four-socket servers
- 4 x quad-core Xeon E7330 2.4 GHz processors (32 cores total)
- 148 GB memory (296 GB total)
- 1 HBA and 4 NICs (2 HBAs and 8 NICs total)
- 4 internal 146.8 GB SAS HDDs (8 HDDs total)

The target server was the new IBM system x3850 X5, equipped as follows:

- 1 x four-socket server
- 4 x eight-core Xeon X7560 2.27 GHz processors (32 cores)
- 256 GB memory
- 1 HBA & 2 NICs
- 8 internal 146 GB SAS HDDs

These servers were deployed on a LAN with the addition of IBM BladeCenter servers, which were used to simulate the SAP client-side workload. The x3850 X5 ran SUSE Linux Enterprise Server 10 SP3. VMs in the Xeon 7330-based systems were created running SUSE Linux Enterprise Server and Windows Server 2003, along with various SAP applications, such as SAP Solutions Manager, SAP ERP, CRM, SRM, BW, PI, EP, and Solman. VMware (vSphere 4.01) with the Site Recovery Manager plug-in was also used.

Implementation

A scale-up approach to virtualization was chosen as the goal, which permits consolidation and optimization of workloads for environments with different systems onto a single large server. Although this topology is easily configurable and inexpensive in comparison to a three-tier topology, a two-tier topology in which all SAP components (including the database) reside on a single machine means that they compete for resources, which could potentially affect the performance of processes. Thus, either a limited SAP environment or else a high-end, powerful server are required. Some of the key advantages of a two-tier system configuration are as follows:

- It uses the power of 64-bit and scalability.
- It delivers the best performance (no overhead for connection to the database, no network traffic, no shadow processes).
- The centralized infrastructure makes it easiest to monitor and manage.

For the PoC, the SAP VMs were successfully moved from the older servers to the new x3850 X5 (Figure 1) without powering down the systems and with no downtime of SAP processes running in the environment. Overall results showed the workload ran three times faster on the SAP systems that were migrated. With the license model of the hypervisor, which is socket-based, this migration would save license costs; with the same number of licenses an organization can host more SAP VMs on an eX5 host system compared to the earlier generation of Intel processor-based hosts.

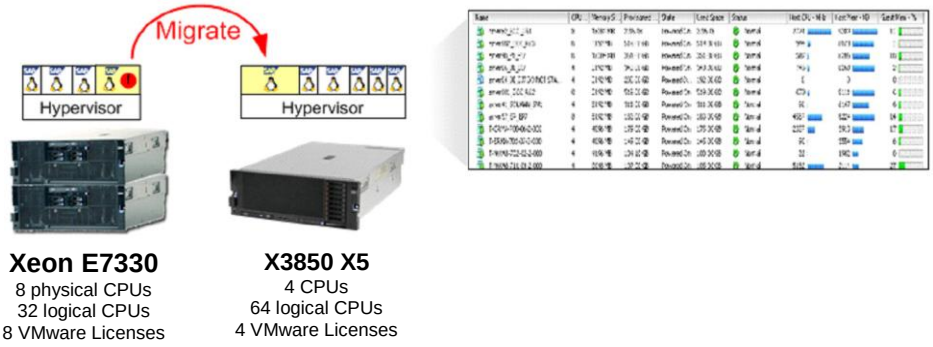

Figure 1. Migration of VMs from Two Xeon E7330 Four-Socket Servers to One x3850 X5 Server

Performance Results

The PoC was intended to validate the superior design of the eX5 server architecture in a complex virtualized environment. Specific attention was paid to CPU and memory utilization as key components contributing to server performance. Because systems management is often the largest and fastest-growing IT cost component as SAP infrastructures become more complex, another primary aim of the PoC was to demonstrate improved visibility into the environment and to streamline administration. This generated graphics, some of which are presented here (Figure 2, CPU Usage, and Figure 3, CPU Real Time), showing critical performance metrics of the system with all the SAP VMs consolidated onto a single x3850 X5 server.

The first of these (Figure 2) shows the CPU usage using a readout from the Rational Performance Tester used to simulate a 1,000-user load in an SAP landscape consisting of 10 VM workloads, including an ERP application, PI, BW, Portal, SRM, CRM, ERP Test, ERP QA, and two NetWeaver systems, all running on a single x3850 X5 server. The load is simulated in six different business scenarios (Purchase Order, Web Services and Portal, Goods Receipt, Business Trip Request, Time Booking, and BW queries).

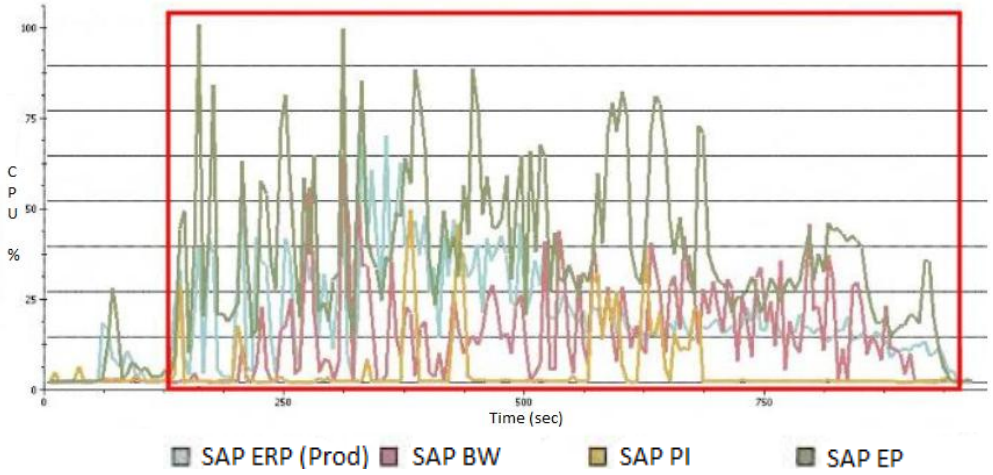

Figure 2.CPU Usage — Rational Performance Tester Monitor

The performance monitor of the vSphere client (VMware) (Figure 3) shows values of host and VM CPUs in real time.

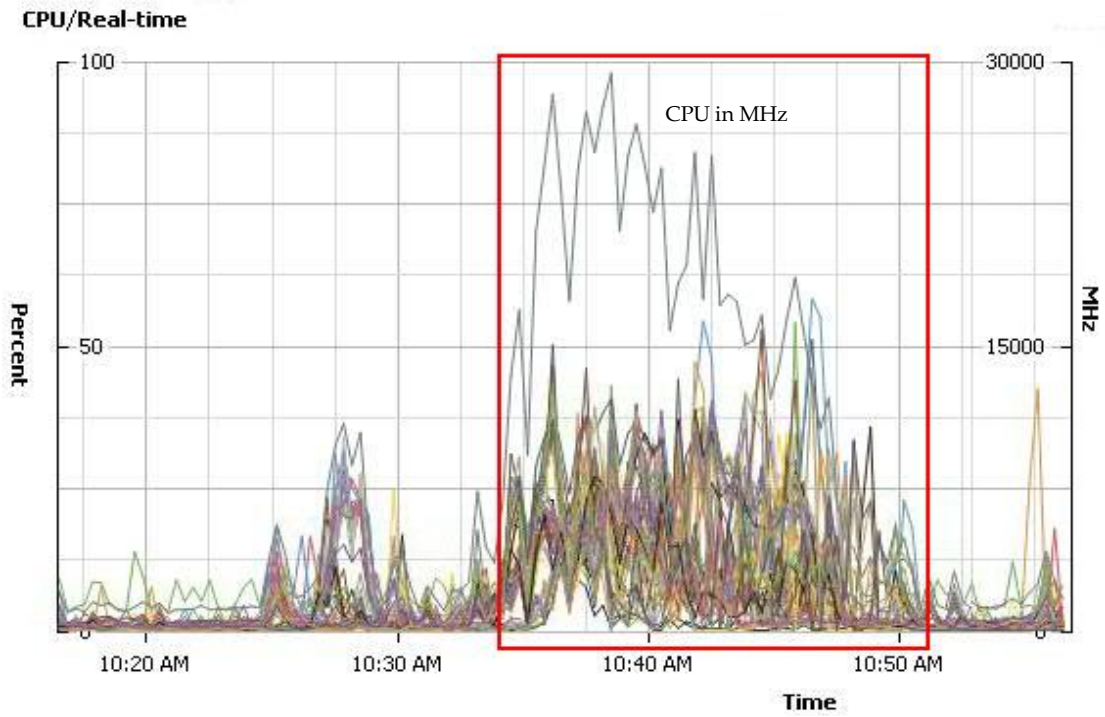

Figure 3. CPU Real Time — vSphere Performance Monitor

The line indicated shows the CPU in MHz. All other lines are CPU usage in percentage. This shows an overall load of below 50 percent utilization of the CPUs in the system.

An extremely critical factor in a consolidated virtualized environment is the utilization of available memory. Memory limitations stand as one of the greatest roadblocks to high-density VM consolidation. Built from the ground up to accommodate virtualized workloads, eX5 servers are designed with memory as a primary consideration. The chart below (Figure 4) shows the values of the host's active memory (red), consumed memory (blue), and granted memory (green) while all six business scenarios are running.

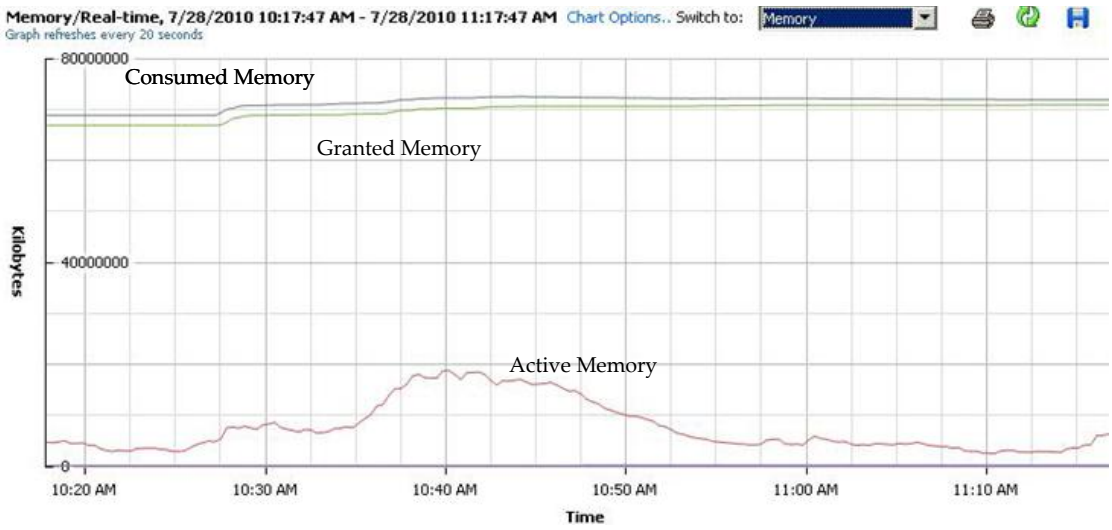

Figure 4. Utilization of Available Memory

The chart above shows that the eX5 architecture can manage the memory utilization of these two very significant virtualized workloads very effectively. An SAP instance running on a VM requires 100 percent of the VM's memory to be reserved for that use (a no-memory-overcommitment policy). Therefore, in addition to overall memory capacity, memory allocation and management are key to being able to virtualize and consolidate more SAP application workloads. IBM eX5 servers offer scalability by enabling same-model servers to be linked and thus operate as a single large server, effectively doubling both processor and memory capacity. Additionally, the MAX5 memory expansion chassis, mentioned earlier, can deliver unprecedented memory configurations, decoupling memory from system processors and overcoming the constraints inherent in the 30-year-old x86 architecture. It offers six times the memory than is available across the industry using two-socket x86 servers, and 50 percent more than competitive four- and eight-socket servers, and scalable memory expansion that can be harnessed to significantly reduce costs by running lower-cost memory on a greater number of DIMM slots, with headroom to grow in the future.

Conclusions

Virtualizing and consolidating complex, business-critical workloads, such as SAP applications, can pay off handsomely in terms of efficient server utilization and use of floor space, reduced maintenance and administration costs, and electrical power usage. This strategy can also boost the bottom line by making it much easier to move and repurpose servers in order to accommodate evolving data center needs or the changing realities of the business itself. Such improved flexibility makes the entire organization more agile in responding to shifting business-related priorities and events.

IBM eX5 servers deliver greater business productivity with three times the performance of industry-standard servers and a capacity of over 2.3 million transactions per minute. Data centers can consolidate up to 32 equivalent 1U machines on to one virtualized eX5 system, with equal performance at less cost for high-performance configurations.

With the Proof-of-Concept described in this white paper, the IBM SAP International Competence Center has demonstrated unprecedented VM consolidation density for SAP landscapes on an eX5 server technology, migrating SAP workloads operating at near-capacity on two of the previously industry-leading x86 servers onto a single IBM x3850 X5 server. The combined view of the complete workload made possible in this virtualized environment revealed no bottlenecks in CPU or memory utilization, and in fact showed the system running with more than adequate headroom and additional capacity to spare.

These results validate that the superior design of IBM's eX5 platform makes it capable of handling the most demanding workloads in a virtualized environment. They also mean that, by consolidating high-end ERP applications from a previous generation of x86 servers to x3850 X5 servers, an organization can achieve three times or greater VM consolidation. This in turn translates to a third of the virtualization (VMware) software licenses required, reduced power consumption, and a third of the physical machines requiring floor space, upkeep, and maintenance, as well as simplifying management of the entire operating environment.

Organizations deploying, or considering deploying, complex workloads such as SAP in virtualized environments cannot afford to ignore IBM's eX5 servers. With cutting-edge performance, highly scalable memory, and mainframe-inspired reliability, availability, and serviceability, these servers exceed the requirements of the most demanding enterprise application workloads.