SCALING VIRTUAL DESKTOPS ON SUN FIRE™ X4600 M2 SERVERS

Evaluating Performance and Capacity with VMware Infrastructure 3

White Paper
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Abstract

Managing desktop environments across the enterprise can be quite challenging for many organizations. Virtualization of desktop systems is an increasingly popular solution, but requires scalability, balanced system design, and sufficient power and performance for successful implementation. This white paper discusses the use of Sun Fire™ X4600 M2 servers as a virtual desktop infrastructure platform.

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Introduction

Virtualization has become a significant IT trend in recent years. Traditionally used with servers and storage to help consolidate and improve utilization, virtualization is a key tool for optimal deployment of computing resources. By consolidating workloads from several smaller servers onto a single larger server, organizations can contain costs, streamline administration, and increase efficiency. Desktop virtualization functions similarly to server virtualization and is rapidly becoming a popular solution that can offer compelling benefits for those faced with the challenges of managing corporate desktop environments. In order to be successful, however, the virtualization servers used as part of a virtual desktop solution require scalability, balanced system design, and sufficient power and performance to support a large number of virtual machines.

Along with Sun hardware, Sun™ Virtual Desktop Infrastructure (VDI) Software addresses the need for suitable performance and power. Sun Fire™ X4600 M2 servers based on AMD Opteron™ processors are engineered with the balanced system design, power, and scalability that is required for virtual desktop solutions. This white paper discusses running virtualized desktops on Sun Fire X4600 M2 servers as part of a virtualization solution, and details a testing effort performed by an independent firm to determine the maximum capacity, performance, and scalability of Sun Fire X4600 M2 servers running in a virtual desktop environment.

Desktop management challenges

The traditional use of individual physical desktop systems can create complex challenges for IT staff. IT departments must deal with constantly-changing requirements for applications and services and multiple different system hardware configurations. Supporting frequent personnel changes and user access through telecommuting and hoteling is a difficult chore at best, and can require a new approach by IT management. Complexity is often left in the hands of users who may not be skilled enough to administer their systems. For example, users may not be equal to the task of keeping virus protection software current or maintaining adequate backups of valuable data. Software and hardware updates and maintenance of supporting hardware and software infrastructure can be time-consuming for even knowledgeable staff. Multiple systems dispersed throughout a corporate environment can require onsite visits to individual users' work areas for effective administration. As a result, routine tasks such as software upgrades or installation of new applications can take weeks or months to accomplish within a distributed environment.

Use of individual systems can also open security holes, introduce viruses, and potentially allow users to remove proprietary corporate data — leaving systems, data, and applications vulnerable. In addition, maintaining or improving application

availability can be difficult when working with multiple individual desktop systems, and use of disparate systems can diminish service levels for applications. The solution to these issues is to centralize computing resources. Fortunately, the technology that can address these challenges exists today.

Desktop virtualization

Desktop virtualization is revolutionizing interactive environments by moving processing off individual physical desktop systems and onto centralized datacenter servers. Users access desktop applications through a range of clients. By locating the applications and even the operating environment itself on a single server within the datacenter, IT staff can streamline system administration, secure and back up valuable corporate data, and provide the workforce with mobile commuting options.

Sun™ Virtual Desktop Infrastructure Software

Sun Virtual Desktop Infrastructure Software delivers full desktop environments to clients through a server-based three-tier computing model depicted in Figure 1. Servers from Sun or other vendors in the back-end virtualization layer provide highly-secure, resilient, and available virtualized desktop environments that meet a wide range of business requirements. These servers run dedicated virtual machines that host the same applications that might otherwise run on user's individual personal computers (PCs). The middle tier consists of Sun Virtual Desktop Infrastructure Software and provides a secure transport between the client devices and the virtual desktop environments hosted on the back-end servers. The client layer can comprise a wide variety of devices, such as Sun Ray™ thin clients, traditional PC systems, and mobile devices.

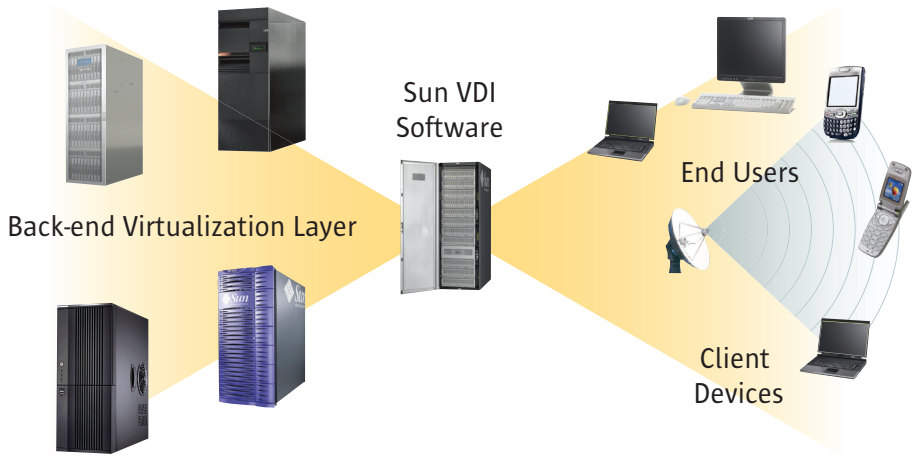

Figure 1. Sun Virtual Desktop Infrastructure Software allows different client devices to access virtualized desktop environments hosted on back-end servers.

Running on the scalable and secure Solaris™ 10 Operating System (OS), Sun Virtual Desktop Infrastructure Software provides dynamic and/or static mapping of end-user connections to server-hosted desktop sessions — also known as brokering. Sun VDI Software integrates with VMware Infrastructure 3 (VI3) software running on the back-end systems to deliver desktop environments running inside virtual machines. Sun VDI Software also makes it possible for clients to access back-end virtual desktops through firewalls, thus supporting remote working scenarios and home access. This functionality is also a powerful solution for business continuity when unforeseen events require that systems be accessed from a new location.

The benefits of virtualization using Sun Virtual Desktop Infrastructure Software

Virtualization has now become mainstream, and it represents one of the hottest trends in the IT industry. Many organizations are discovering the numerous benefits to implementing a virtual desktop environment. Sun Virtual Desktop Infrastructure Software helps to deliver these benefits, including:

- Greater security — Incorporating state-of-the-art security features combined with the latest user authentication, firewall, and encryption technologies, Sun Virtual Desktop Infrastructure Software helps to create a platform that organizations can rely on to protect valuable business information.
- Higher ROI — IT departments can extend the useful life of aging desktop PCs by eliminating the costs and hassles associated with maintaining them. As well, when coupled with Sun's Open Storage architecture, customers will quickly realize tremendous cost savings with the reduced amount of storage required to support their VDI deployment.
- Lower TCO — Virtual desktop infrastructure reduces operational and administrative costs and lowers hardware costs that are factored into the TCO equation. With a certified mean time between failures (MTBF) of over 200,000 hours — or approximately 22 years — deploying Sun Ray 2 and 2FS Virtual Display Clients can help organizations extend desktop refresh cycles far beyond the industry standard cycle of three years.
- Rapid deployment — New desktops can be provisioned in a matter of minutes instead of days, and achieving ROI can be accomplished more rapidly and easily using a virtual desktop infrastructure implementation.
- Maximize IT infrastructure — The centralized Sun VDI Software architecture seamlessly integrates with almost any existing IT infrastructure, providing powerful control to the administrator, and making it possible to upgrade applications for all users with a single operation.

- Open architecture — Sun VDI Software and its open architecture provide a broad choice of client device, virtualization host, and attached storage systems, as well as the virtual desktop OS. OS support includes access to Windows XP, Windows Vista, Windows 2000, OpenSolaris™, and Ubuntu Linux environments.
- Anytime, anywhere access — Virtual desktops can be accessed not only from traditional PCs and thin clients such as Sun Ray thin clients, but also from virtually any Remote Desktop Protocol (RDP) enabled device or Java™ technology-enabled web browser. Access is provided using high encryption security standards, delivering secure session mobility through hot-desking and hoteling.
- User-friendly — The Sun VDI architecture provides a highly-manageable environment while still allowing users to customize desktops to meet individual requirements.
- Compliant — Maintaining compliance with industry or government legislation and internal corporate policies is far easier due to the centralized nature of the Sun VDI architecture. Backups can be administered for retention of valuable corporate assets and preservation of data for regulatory oversight.
- Eco efficiency — In addition to capital and operating expense savings such as lower equipment costs, lower energy consumption, reduced cooling, and smaller physical footprint, the exceptional virtualization options provided by Sun VDI software simplify administration, lower lifecycle costs, and reduce the overall impact on the environment.

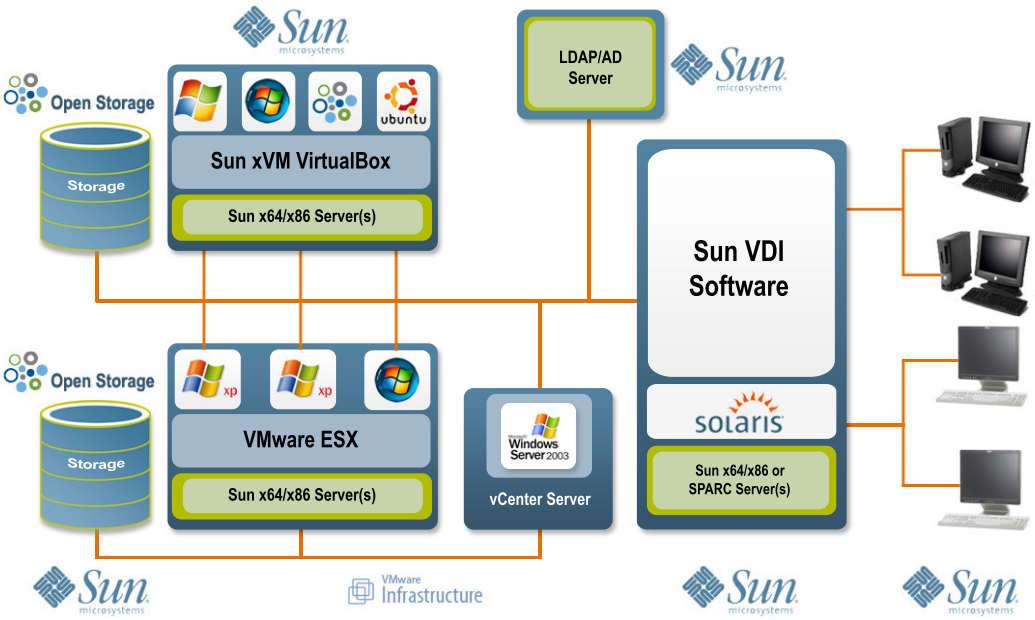

Figure 2. The Sun Virtual Desktop Infrastructure Software architecture

Sun Virtual Desktop Infrastructure Software architecture

The Sun Virtual Desktop Infrastructure Software topology consists of a variety of elements as depicted in Figure 2. Principal components of the Sun VDI infrastructure include:

- *Virtualization*
  The industry's only truly complete desktop virtualization solution, Sun VDI software provides powerful administration and flexibility of virtualization hosts, delivering integrated support for both Sun xVM Virtual Box software as well as VMware's Virtual Infrastructure suite. VMware Virtual Infrastructure offers comprehensive virtualization, management, resource optimization, application availability, and operational automation in an integrated product suite. Both VMware ESX Server and Sun xVM Virtual Box software provide robust management and host multiple virtual desktops installed on the centralized datacenter server.
- *Sun VDI Software*
  A brokering service is the key element within Sun VDI Software that connects the client devices with the virtual desktops on the datacenter server. Sun VDI Software makes it easy to control the complete lifecycle of virtual machines, assign users to virtual desktop environments, and provide end-users the flexibility of choosing their desktop environment, if desired.
- *Client systems*
  Sun VDI software provides secure access from a wide range of popular client devices, including PCs, laptops, workstations, mobile devices, Apple Macintosh computers, thin clients, or nearly any RDP enabled device. Multiple client instances can be utilized for maximum horizontal scaling. Clients communicate with the Sun VDI Software to access centralized desktops running on Windows, OpenSolaris and Linux operating systems.

Evaluating virtual desktop performance on Sun Fire X4600 M2 servers

Servers comprise a key component of the VDI solution, and server performance is critical in any virtual desktop infrastructure. Sun Fire X4600 M2 servers based on AMD Opteron processors offer a highly-scalable and balanced design that serves as an excellent platform for a Sun Virtual Desktop Infrastructure Software solution. To evaluate the viability of these servers as part of a VDI solution, Sun contracted with a third party testing company to perform independent testing of the VMware Virtual Infrastructure 3 software running on Sun Fire X4600 M2 servers[1].

1. Testing was conducted at VeriTest's Lionbridge test facility in Oakdale, Minnesota.

Testing environment

While the overall solution performance depends on many factors, testing of the Sun VDI Software solution focused solely on server performance running VMware Virtual Infrastructure software. VeriTest performed testing on a Sun Fire X4600 M2 server configured with eight 2.3 GHz quad-core AMD Opteron 8356 processors with 256 GB RAM, four Gigabit Ethernet ports, and four 72 GB 10K RPM serial attached SCSI (SAS) drives.

The Sun Fire X4600 M2 server was connected to the VMware Service Console through a Cisco Catalyst 3500 XL 100 Mb LAN switch. A Netgear GS748T Gigabit network switch connected the Sun Fire X4600 M2 server running the virtualized desktop environments to the server running Windows Active Directory and VMware VirtualCenter Server 2.5. The topology is illustrated in Figure 3.

A Brocade 3800 Fibre Channel Fabric Switch connected a Sun StorageTek™ 6140 array to the Sun Fire X4600 M2 server. The storage array was configured with dual controllers, each containing two Fibre Channel ports connected to the Brocade switch. The switch was configured with two zones, the first connecting Port1 from the Sun Fire X4600 M2 server's host bus adapter (HBA) to Port1, Controller A on the Sun StorageTek 6140 array. The second zone connected Port2 from the Sun Fire X4600

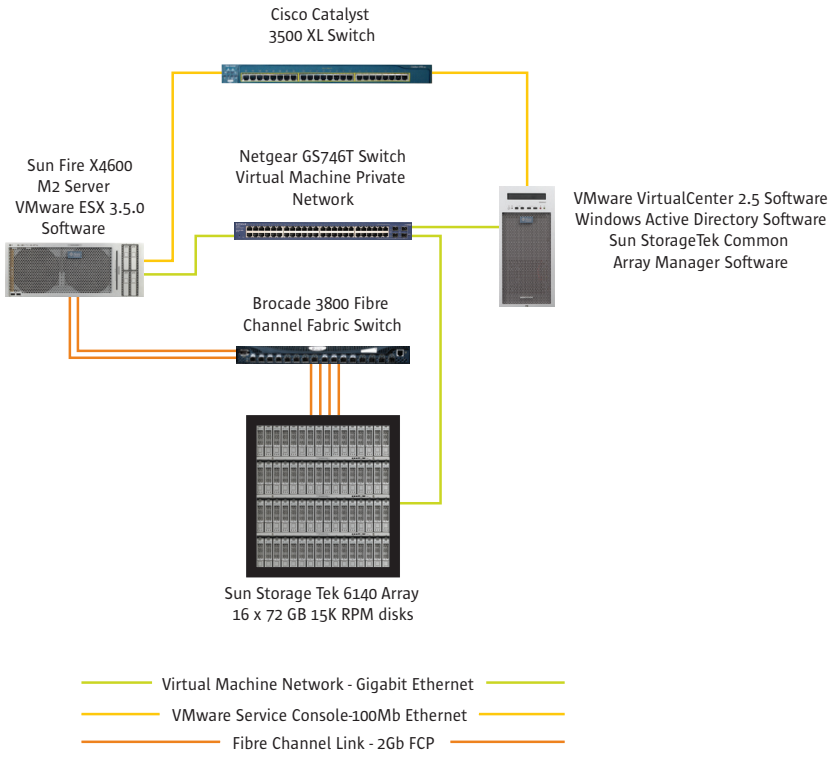

Figure 3. The topology used to test the performance and capacity of virtual desktops on Sun Fire X4600 M2 servers

M2 server's HBA to Port1, Controller B on the Sun StorageTek 6140 array. In this manner, the eight storage volumes were evenly balanced across the two controllers of the Sun StorageTek 6140 array. Using the `Microsoft_NTFS` profile, the Sun StorageTek 6140 array was configured with eight volumes to provide storage for the virtual machines. Four disks were allocated in a 3+1 RAID5 configuration for each of the eight volumes. If needed, a total of 20 virtual machines could be allocated to each volume.

A separate physical server was installed with Windows Server 2003 R2 Enterprise Edition software and configured with dual 2.8 GHz Intel® Xeon® processors, 4 GB RAM, dual Gigabit Ethernet network interface cards (NICs), and two 36 GB 15K RPM Ultra320 SCSI hard disk drives in a RAID1 configuration. This server provided Windows Active Directory services to the virtual desktops, ran VMware vCenter Server 2.5 software for the VMware Service Console, and managed the Sun StorageTek 6140 Array through Sun StorageTek Common Array Manager software installed on the server.

About Sun Fire X4600 M2 servers

For purposes of this series of tests, a Sun Fire X4600 M2 server was selected to host the VMware VI3 software running Windows XP inside multiple virtual machines. The Sun Fire X4600 M2 server is the industry's most compact enterprise-class eight-socket x64 server. Supporting up to eight AMD Opteron processors, the Sun Fire X4600 M2 server can contain up to four SAS disk drives and a maximum of 512 GB of memory in a 4 rack unit (4U) form factor. Sun's x64 systems provide flexibility and the power of choice for the future — running the Solaris OS, Linux, VMware, and Windows software. Containing more power in less space, Sun Fire X4600 M2 servers are the logical choice for applications in enterprise computing, commercial high-performance computing (HPC), Web serving, and server consolidation, as well as desktop consolidation.

The scalable performance and proven reliability of Sun Fire X4600 M2 servers supports compute-intensive enterprise applications and desktop consolidation in virtualized environments. Powered by Dual-Core, Quad-Core, or enhanced Quad-Core AMD Opteron processors, Sun Fire X4600 M2 servers provide superior architecture combined with cost-efficient high performance. The compact 4U footprint offers compute density that can scale to meet increased computing demands. The modular design of the Sun Fire X4600 M2 server increases ROI, making it possible to upgrade to next-generation processors with minimal impact. With support for multiple operating systems, Sun Fire X4600 M2 servers provide additional flexibility and lower TCO.

AMD Opteron processor-based servers are an excellent choice for enterprise infrastructure applications such as desktop virtualization. Well-suited for high-density datacenter deployments, AMD Opteron processors are an ideal solution

for managing cooling and density challenges. With the compute power necessary for intensive computing applications and workstation solutions, AMD Opteron processors provide businesses with the performance headroom needed to confidently and efficiently power virtualized desktop environments.

Sun StorageTek™ 6140 array

One of the best price/performance arrays in its class, the Sun StorageTek 6140 array combines performance, high availability, and reliability all in one economical package. The Sun StorageTek 6140 array features a redundant design and non-disruptive upgrades to provide exceptional data protection for business-critical applications. With dual Fibre Channel RAID controllers, and capable of scaling to 112 TB, the Sun StorageTek 6140 array supports high-performance Fibre Channel (FC) and high-capacity SATA drives.

Software and virtual machines

During testing the Sun Fire X4600 M2 server ran VMware VI3 software. VeriTest engineers also installed WorldBench 5.0 software within the virtual machine template located on the Sun Fire X4600 M2 server. The PC World WorldBench v5 software can be used to simulate workloads generated by a typical enterprise desktop user. Using real applications running real-world tasks to assess overall performance, the WorldBench application launches Microsoft Office XP applications and then simulates the opening, closing, creation, and modification of files in Word, Excel, PowerPoint, Outlook, and Access. WorldBench runs the various simulations simultaneously at the fastest rate the target system can execute.

An internal disk on the Sun Fire X4600 M2 server stored a template of the Windows XP x86 Service Pack 3 (SP3) virtual machine image in a default datastore. This single source virtual machine (VM) template was used to replicate the virtualized desktops. Each VM was configured with a single virtual CPU, 512 MB of RAM, a single 8 GB hard disk drive image, and a single NIC using the VMware flexible adapter option. Engineers replicated the VM image using the VMware VI3 cloning capabilities. To make each cloned VM image unique, engineers then modified the VM hostname and joined it to the Windows Active Directory domain.

Testing objectives and methodology

The goal of the testing was to determine the maximum number of virtual machines acting as virtual desktops that could run successfully on the Sun Fire X4600 M2 server without degrading performance on the VMs. A CPU load level of 95% was agreed upon as the maximum sustained utilization level that could still allow for some overhead in the event of a short spike in usage by a small number of the VMs. To determine the maximum number of VMs, engineers using the virtual desktop

template gradually increased the number of VMs running the simulated workload, and monitored CPU performance using the VMware ESX Server's monitoring utility, `esxtop`.

VeriTest formulated a test methodology such that Windows XP x86 SP3 virtual machines were configured with a workload that simulated an average desktop user experience using the PC World WorldBench v5 application. Each WorldBench instance was configured to execute the Microsoft Office XP profile for a total of 15 cycles to ensure a minimum of three hours of test execution time. This minimum amount of time was needed to capture sufficient simulated workload data to determine the maximum number of VMs that could be supported on the Sun Fire X4600 M2 server.

Additional considerations were made, including:

- The simulated load placed on the VMware ESX host could be greater than what a typical user might achieve using the same applications, due to the rapid nature of the WorldBench application tasking.
- The WorldBench application is designed for physical environments and cannot account for the nuances of shared resources in a virtual environment. The testing focused on the performance of the Sun Fire X4600 M2 server only, but during all test runs individual VMs were sampled to ascertain that the application performance fell within a reasonable range.
- Since the WorldBench software runs locally on the target system, the effects associated with accessing VMs over a network connection (such as from a Sun Ray thin client) were not considered as part of the Sun Fire X4600 platform performance testing.

Testing was initiated with a baseline load of 120 VMs, determined by CPU resources and the overall server configurations. An `esxtop` monitoring session captured the various metrics being reported, and a real-time `esxtop` session allowed VeriTest engineers to monitor CPU and RAM loads placed on the server as the number of VMs in the test cycle increased. The Sun Fire X4600 M2 server was also monitored for any other performance-related alerts, and all the tests were executed twice to help ensure that results were repeatable. The maximum VM load ran for a minimum of three hours for each test run to ensure that the average load was sustained at 95% for this extended period of time.

Test results for the Sun Fire X4600 M2 servers

As the goal of the testing was to determine maximum capacity, test results should be interpreted as guidelines only. For the first test of 120 simulated VMs, the CPU utilization ran at approximately 74%, well below the designated maximum utilization of 95%.

A second test was run with a simulated load of 140 VMs, with the CPU utilization for the second test reaching an average of 79%, still leaving ample headroom for more virtual machines. As a result, a final test was executed to attempt to push the utilization of the Sun Fire X4600 M2 server even higher. The CPU utilization finally reached 93% when running 160 VMs, a considerable number of desktop-configured virtual machines for a single 32-core server to support.

Figure 4 illustrates the CPU load for the initial test of 120 VMs, running over a period of three hours. To produce three hours worth of data, the WorldBench software ran the Microsoft Office XP workload 15 times. At the beginning of each of the 15 cycles, the WorldBench software performed a variety of configuration changes and updates and then rebooted each VM. Changes were reset to the initial state at the end of

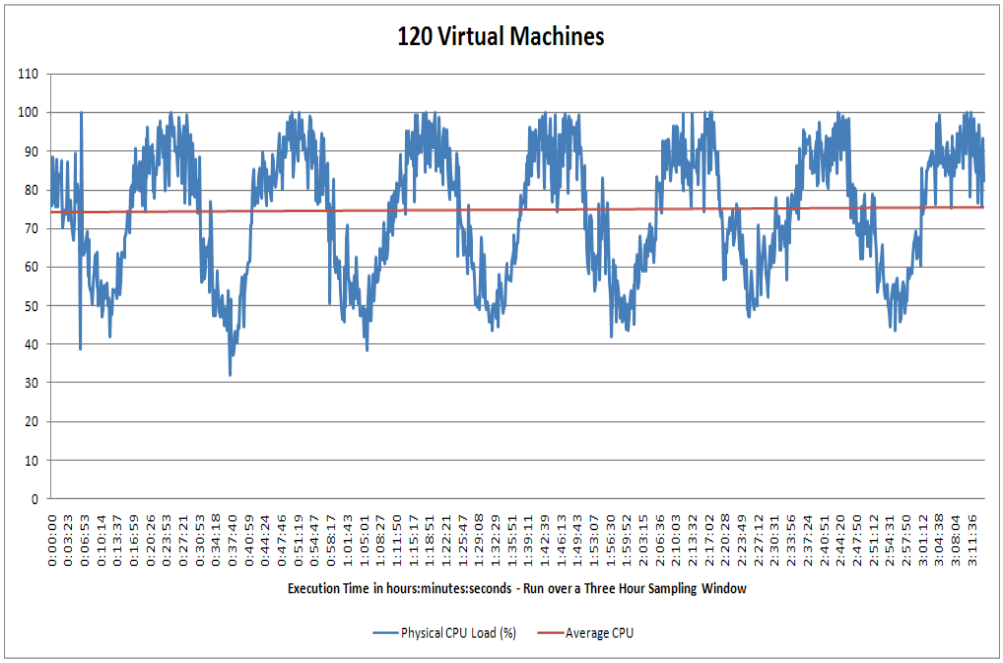

Figure 4. The CPU load for 120 virtual machines

the cycle and each VM was rebooted once more. The valleys in Figure 4 indicate the reboots, and the peaks show the periods when the Microsoft Office XP workloads were executing.

Figure 5 illustrates the second test running a simulated load of 140 VMs, executed over the period of three hours. CPU utilization was sampled every 10 seconds and reached a maximum level of 79%.

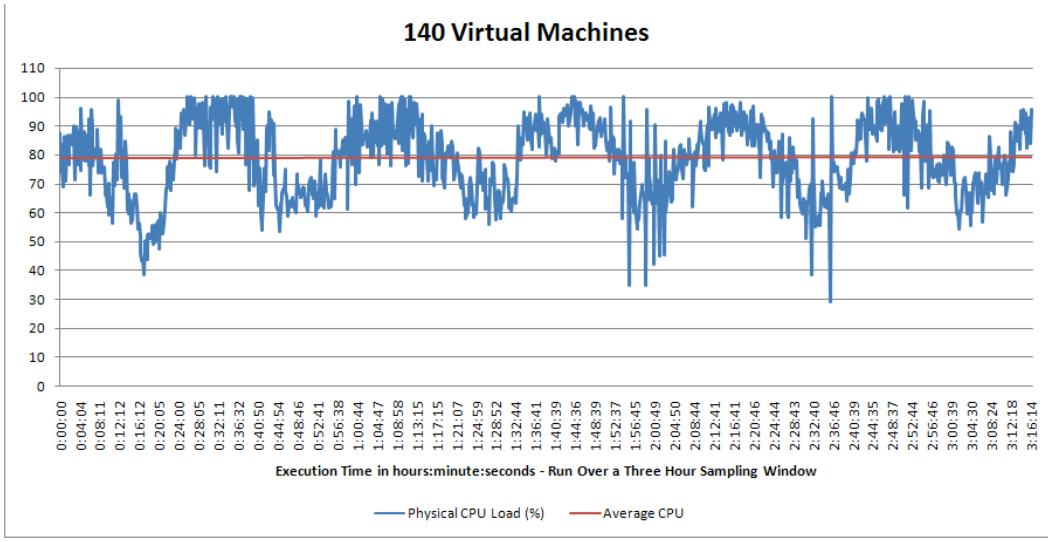

Figure 5. The CPU load for 140 virtual machines

The final test simulating 160 VMs is depicted in Figure 6 and was executed over a period of three hours. At no time during the testing of up to 160 VMs were any VMware ESX alerts issued to indicate resource contention within the Sun Fire X4600 M2 server. The only alerts received concerned CPU utilization, and appeared when the load began to reach 95%, during the final test of 160 VMs. Figure 6 illustrates the CPU load for 160 virtual machines, running at approximately 93% for the entire test cycle, with peaks and valleys indicating execution of the test cycle application workloads and VM reboots respectively.

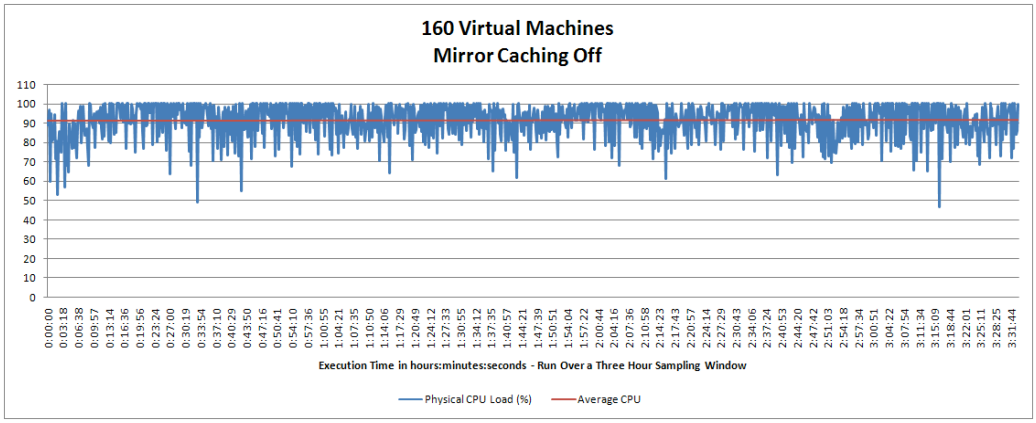

Figure 6. The CPU load for 160 virtual machines

Scalability

WorldBench benchmarks are geared to run specific workloads at higher rates than would be found in a real-world scenario. For this reason, test engineers believe that greater numbers of virtual machines could be supported on Sun Fire X4600 M2 servers than were seen in the results of the tests.

At the same time, the reader is cautioned that these tests were designed to determine the number of virtual desktops that could be supported by a maximum CPU load capacity of 95%, allowing for some overhead in the event of a short spike in usage by a small number of the VMs. A standard of 95% utilization may or may not be a desirable operating level for production environments and it is up to individual organizations to determine what utilization levels will be optimal for day-to-day operations. The three tests demonstrate the excellent scalability of Sun Fire X4600 M2 servers.

Conclusions

During the testing effort, engineers looked to pinpoint the the maximum number of virtual machines that could run without degrading performance on the VMs. For the purposes of these tests, a level of 95% utilization was determined to be the upper limit for suitable system performance. Testing showed that a Sun Fire X4600 M2 server running on Quad-Core AMD Opteron processors can support as many as 160 Windows XP virtual machines when running a typical desktop load, handling a substantial number of virtualized desktops on a single server.

Sun Virtual Desktop Infrastructure Software is a comprehensive desktop virtualization solution that helps to reduce cost and complexity while providing reliability and security , improving ROI, and reducing TCO. Combining next-generation VMware VI3 software with Sun's Virtual Desktop Infrastructure Software results in a new level of virtualization capabilities, high performance, and new virtualized usage models such as high availability, disaster recovery, and dynamic load balancing. The results of the VeriTest testing efforts demonstrate that running VMware VI3 software on Sun Fire X4600 M2 servers provides a robust, high-performance virtualization environment that easily supports large numbers of virtual machines. Deploying Sun Fire X4600 servers as part of a Sun VDI solution can help organizations to strengthen IT operations, reduce capital and operating expenses, and minimize administration efforts.

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