

Lab Validation Report

HP ProLiant DL980, Intel Xeon, and VMware vSphere 5 SAP Performance Analysis

Effectively Virtualizing Tier-1 Application Workloads

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Hewlett Packard, Intel, and VMware.

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Introduction

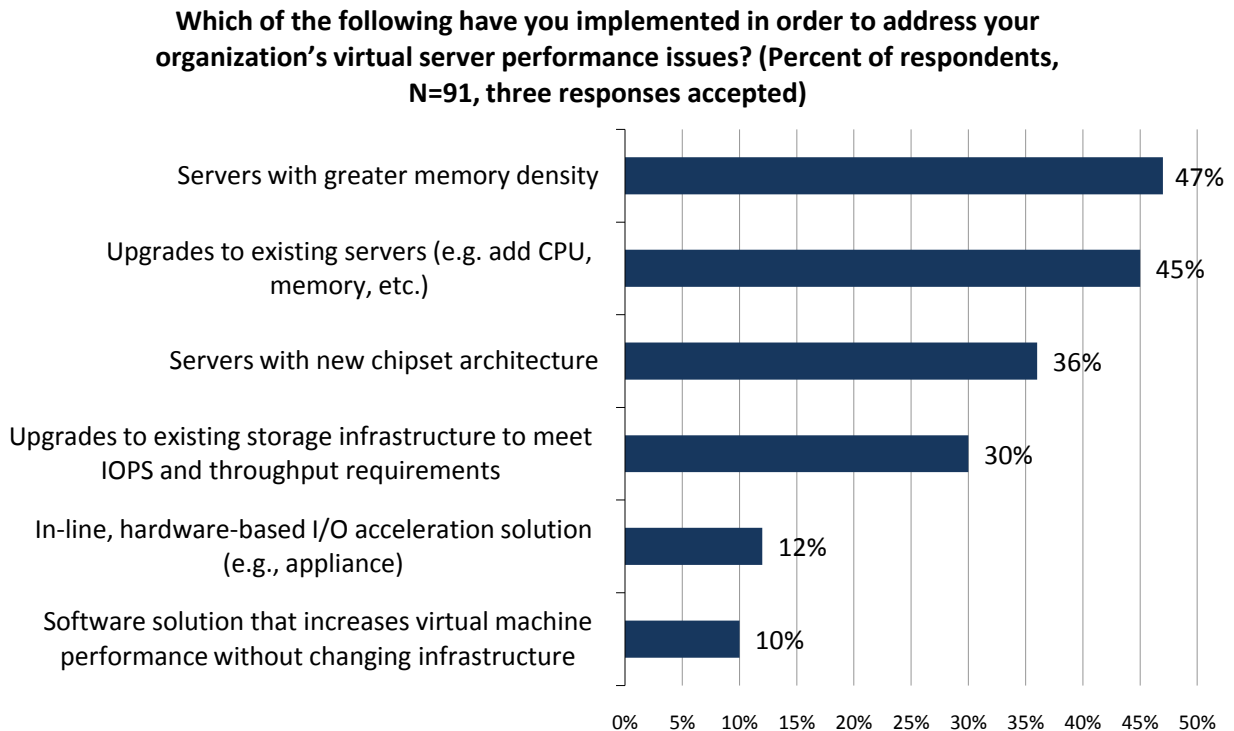
This report presents the results of ESG Lab testing of the performance and scalability of the [HP ProLiant DL980](#) server powered by [Intel Xeon](#) processors, running SAP with [VMware vSphere 5](#). Testing was conducted with a virtualized, tier-1 SAP application workload running on a massively scalable HP ProLiant DL980 server powered by next-generation Intel processors, running VMware virtualization software. The tests were designed to confirm that virtualized infrastructure built with these components can be used to lower cost of ownership, increase scalability, and provide excellent performance while maintaining the reliability and availability required by tier-1 applications.

The Stages of Server Virtualization

Many organizations are currently reaping benefits of server virtualization that include lower IT capital and operating costs and greater IT efficiency. Organizations with server virtualization experience are moving beyond these benefits to improve application provisioning, maintenance, availability, and backup/recovery processes. Server virtualization’s benefits appear to be closely correlated to users’ experience and confidence in the technology.

Over time, organizations tend to move through three distinct stages as they deploy server virtualization technology, beginning by virtualizing IT-owned infrastructure applications and utilities like file and print services. The key objectives during this first wave of virtualization are consolidation, manageability, and cost reduction. As organizations gain confidence in virtualization technology, more intensive applications like Exchange, SQL, and SharePoint are consolidated during the second wave of adoption. In this stage, the agility and availability of IT services are often enhanced as IT managers take advantage of virtualization to migrate applications from physical servers to the increased fault tolerance provided within the virtualization layer. As organizations continue on their virtualization journey, ensuring the performance and scalability of tier-1 applications like SAP is a key objective. ESG asked IT professionals what strategies they have implemented to address virtual server performance concerns. As seen in Figure 1, server architecture plays a huge role, with increased memory density and additional CPU capacity being key considerations.

Figure 1. Virtualization Performance Strategies



Source: Enterprise Strategy Group, 2011.

Server Virtualization is a Top IT Priority

Server virtualization is becoming ubiquitous as a strategic initiative for IT organizations around the world. Of the 1,602 respondents to a recent ESG research survey, nearly three-quarters (74%) said their organization currently uses server virtualization.¹ In addition, as part of its annual IT spending intentions research, ESG surveyed senior IT professionals concerning their organizations' most important IT priorities, and increasing the use of server virtualization was the number one response. Server virtualization is clearly their most important priority for the coming year and beyond, making it the third year in a row that it has ranked at the top of the priority list.² Businesses recognize the value that server virtualization delivers and will continue to make investments in the technology in order to drive further efficiencies in their IT environments.

ESG's data has confirmed that a massive wave of server virtualization expansion is well underway. For example, while 73% of organizations have virtualized 40% or less of their total population of servers today, 58% expect to virtualize more than 40% of all of their servers 24 months from now. The data also indicates that more of these new virtual servers will be run in production environments—on average, the percentage of VMs run in production will increase from 39% today to 58% within two years.³

Given the fact that 59% of organizations surveyed by ESG have not yet virtualized tier-1 applications and that the greatest benefits to be gained with virtualization come with the virtualization of these data-intensive applications and workloads, ESG expects to see an increasing number of organizations tackling tier-1 virtualization.

Overcoming Tier-1 Virtualization Concerns

While server virtualization adoption continues to gain momentum, IT organizations still have numerous hurdles to overcome in order to move closer to a 100% virtualized data center. ESG's data indicates that many organizations struggle with concerns over performance, technology complexity, integration, security, organizational confusion, and a basic lack of knowledge and skills that they believe will be vitally important when virtualizing tier-1 application environments.

When it comes to virtualizing multi-user tier-1 applications essential to the business, in addition to the general concerns already cited, organizations have additional worries:

- Will the virtualization layer add significant performance overhead?
- Can the virtualized infrastructure scale to continue to meet their needs?
- Can performance SLAs for virtualized tier-1 applications be met with confidence?

Despite the challenges, experienced organizations with more mature virtualization deployments are rapidly moving beyond the initial benefits of consolidation, finding that more extensive use of virtualization can help improve application backup/recovery, bolster application availability, and automate IT processes. They have come to realize that the real metrics that matter in a virtual environment are those focused on availability and performance, and measure the success of their virtualization efforts not only by their ability to reduce costs and increase efficiency, but also by their ability to meet application performance requirements.

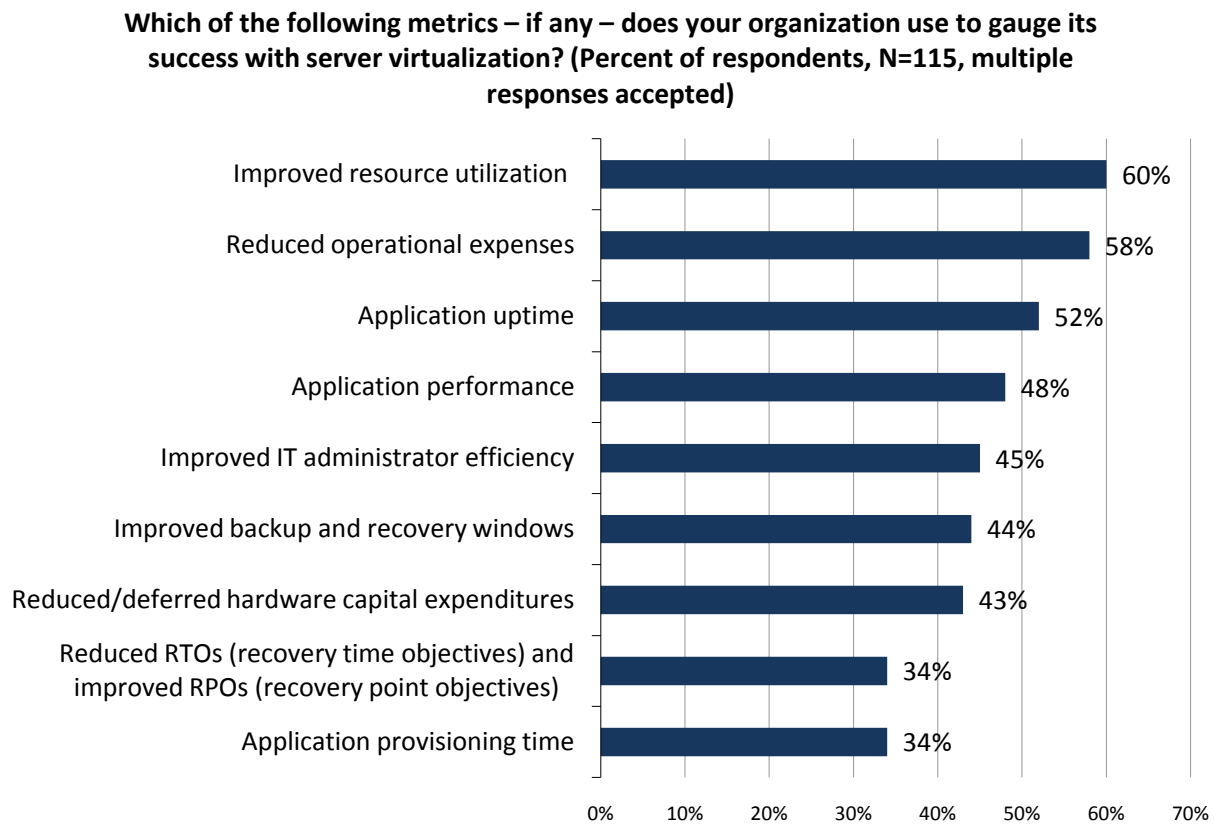
Of these more mature organizations surveyed by ESG, 52% cited application uptime and 48% indicated performance among the metrics used to gauge the success of their virtualization deployments, as can be seen in Figure 2.

¹ Source: ESG Research Report, [The Evolution of Server Virtualization](#), November 2010.

² Source: ESG Research Report, [2011 IT Spending Intentions Survey](#), January 2011.

³ Source: ESG Research Report, [The Evolution of Server Virtualization](#), November 2010.

Figure 2. Metrics for Gauging Virtualization Success



Source: Enterprise Strategy Group, 2011.

Many of these early adopter organizations have now virtualized their entire infrastructures, including tier-1 applications like SAP. In other words, application performance is a top criterion for virtualization success that is being addressed by the early adopters that have fully embraced server virtualization.

The HP ProLiant DL 980, Powered by Intel Xeon Processors with VMware vSphere 5

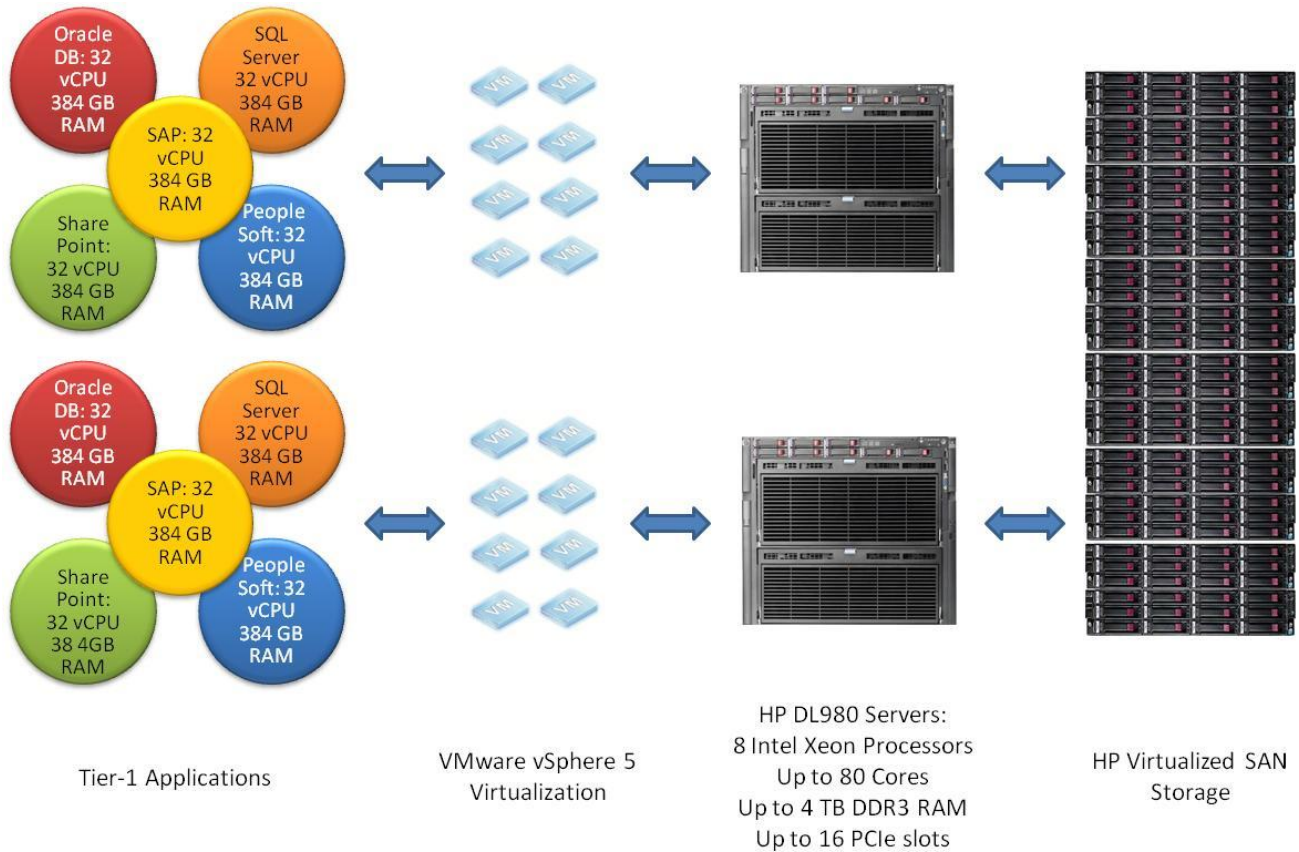
New technologies and offerings from HP, Intel, and VMware seek to address these performance and scalability concerns. The HP ProLiant DL980 G7 is designed to reduce bottlenecks and improve throughput and performance as well as deliver enhanced reliability in an x86 environment.

Scaling up to 80 total cores with Intel Xeon E7 4800 and 7500 Series processors, up to 4 TB of memory, 16 IO slots, and HP Integrated Lights-Out 3 (iLO 3) remote server management software, the DL980 G7 server is a platform designed for organizations looking for balanced scalability and self-healing resiliency for today's enterprise compute environments.

VMware vSphere 5 is designed to take advantage of these massive scale-up servers and new processor technology, with support for up to 2048 vCPUs and 2 TB of RAM per host, and support for up to 32 vCPUs and 1 TB of RAM per virtual machine. In addition, VMware has introduced support for multi-core virtual CPUs which allows VMs to use advanced memory management features in server hardware as if it were on a physical machine.

Figure 3 shows how HP, Intel, and VMware offerings can be leveraged to provide a robust, massively scalable virtualized environment for the most critical tier-1 applications running in enterprises today.

Figure 3. Virtualization of Tier-1 Apps with HP, Intel, and VMware



A growing number of businesses are looking beyond the initial benefits of increased consolidation and manageability that can be achieved when virtualizing tier-1 application workloads. And yet, as previously referenced, 59% of organizations have not yet virtualized tier-1 applications. Performance concerns are among the reasons most cited as preventing companies from using virtualization more pervasively. The balance of this report summarizes the results of ESG Lab testing designed to evaluate the scalability and performance of a tier-1 SAP ERP application workload running on an Intel Xeon-powered HP ProLiant DL980 server fully virtualized with VMware vSphere 5.

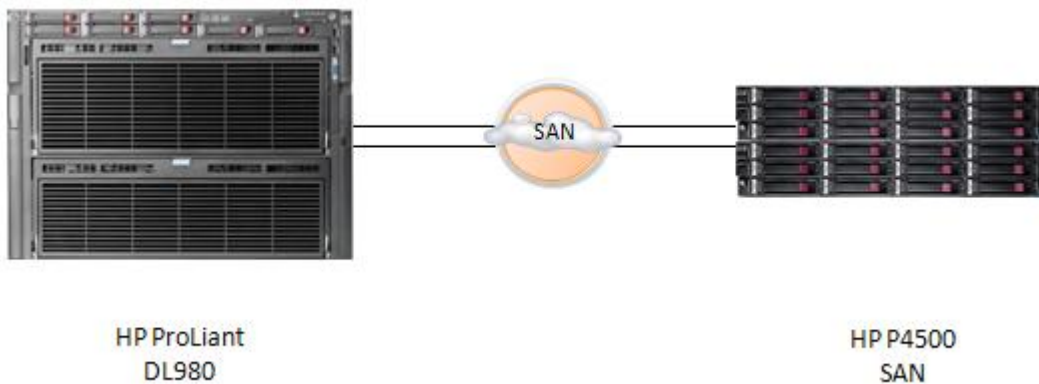
ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of virtualized tier-1 application workloads in VMware's facilities in Palo Alto, California utilizing HP's ProLiant DL980 server with VMware's vSphere 5 running SAP ERP 6.0. The workload used was designed to emulate a number of different user activities in a sales and distribution environment executing several different transactions.

Getting Started

Figure 4 illustrates the test bed used by ESG Lab. SAP ERP 6.0 was installed in a VMware vSphere 5 virtual machine running on an HP ProLiant DL980 server configured with eight Intel X7560 8-core CPUs and 512 GB of DDR3 system RAM. While the DL980 can support up to 2 TB of RAM today and 4 TB with 32 GB DIMM modules in the near future, 512 GB was more than sufficient for the tests described in this report. Storage services were supplied by an HP P4500 SAN over a 1Gbps iSCSI SAN.

Figure 4. The ESG Lab Test Bed



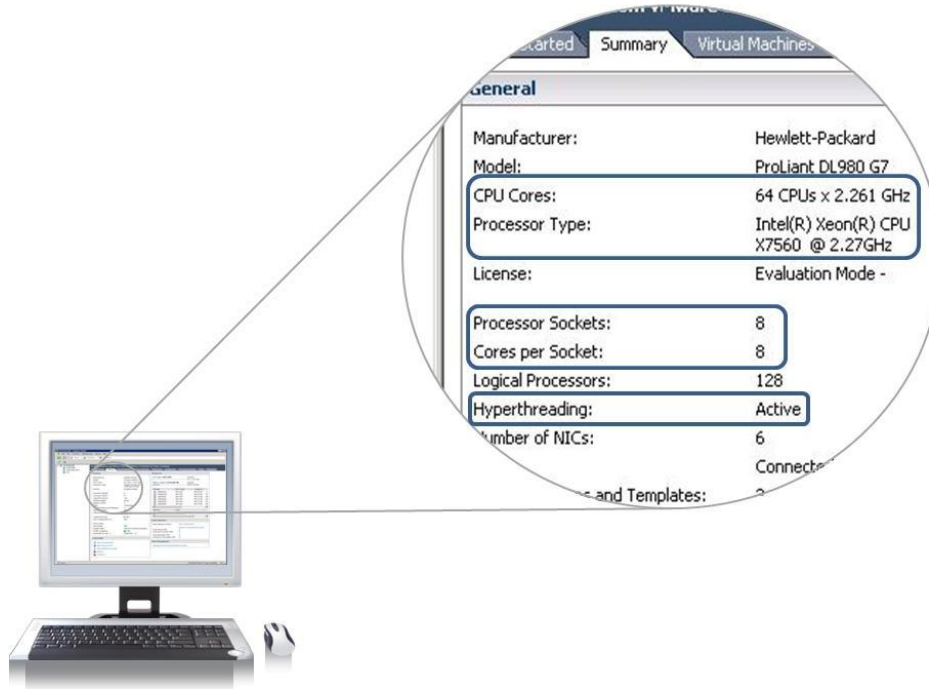
Testing was executed in a repeating loop against an SAP installation where all components (application and database servers) were installed and running on one virtual machine. While the workload was running, different aspects of virtual machine hardware utilization were measured as well as application response time. The testing simulated a sell-from-stock business model and included the creation of a customer order with multiple line items, delivery of the order, shipment, and invoicing.

This workload is resource-intensive and is intended to gauge the expected performance of the tested server platform and configuration in a virtualized SAP environment.

ESG Lab Testing

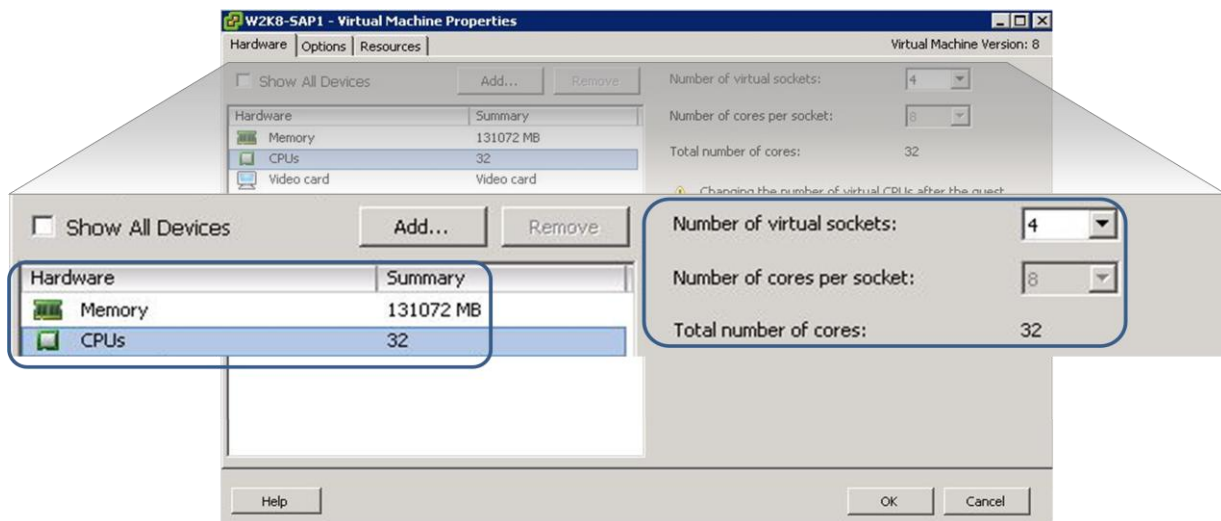
Figure 5 shows the HP ProLiant DL980 as seen in the vSphere 5 console, with eight 8-way Intel Xeon processors installed and hyperthreading enabled.

Figure 5. The DL980 G7 in vSphere 5



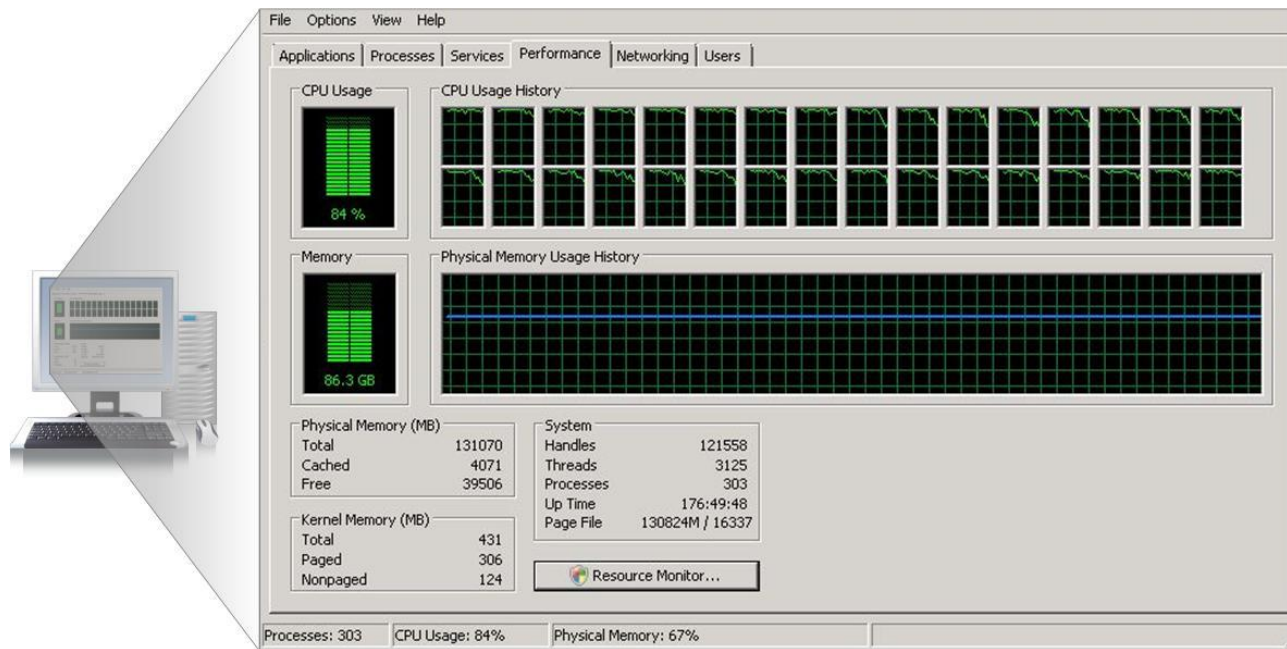
Testing was performed against a single virtual machine with 4, 8, 16, and 32 vCPUs. Each virtual machine had RAM allocated in proportion to the number of vCPUs assigned, from 16 GB for the 4 vCPU virtual machine to 128 GB for the 32 vCPU machine, as seen in Figure 6. It's important to note that vSphere 5 allows administrators to configure the number of virtual sockets, enabling optimized VM memory management. It is also important to note that unlike physical machines, virtual machines can easily have CPU and RAM resources added or subtracted at any time, making the VM easier to dynamically scale to meet increasing or decreasing performance demands.

Figure 6. The SAP ERP 6.0 Virtual Machine with 32 vCPUs and 128 GB of RAM



ESG Lab ran a CPU-intensive portion of the test workload and captured the screenshot shown in Figure 7.

Figure 7. 32 vCPU Virtual Machine Under Load



This workload was run in a loop for several minutes. The virtual machine distributed the load quite evenly across all 32 vCPUs. It's important to keep in mind that while most workloads don't require the maximum VM configuration of 32 vCPUs and 1 TB of RAM, vSphere 5 was able to manage large memory and vCPU allocations in a VM quite well, and it's reasonable to expect similar results for configurations with larger RAM configurations.

Why This Matters

SAP ERP has long been a vital, data-intensive tier-1 application for many businesses, functioning as the primary means of managing inventory, sales, and delivery of goods and services. IT executives treat SAP as one of the most critical applications they support as they strive for an optimal balance of performance, availability, and cost effectiveness.

Gaining confidence with server virtualization, businesses are now ready—and willing—to move their next tier of applications and IT services to virtualized environments. HP ProLiant DL980 servers powered by Intel Xeon processors provide the infrastructure required to virtualize larger workloads with higher utilization than is possible in a physical environment. VMware vSphere 5 gives administrators the ability to leverage the massive scalability of the HP DL980 with up to 32 vCPUs and a 1 TB of RAM in a single virtual machine. IT organizations can also leverage vSphere to create a test environment that will help them test and plan for a highly successful migration and decrease the time required to move from pilot to production.

ESG Lab confirmed that VMware vSphere 5 was able to effectively virtualize a CPU-intensive SAP workload running on an HP ProLiant DL980 server, evenly distributing the workload across 32 vCPUs. It's important to note that the DL980 was using less than 50% of its available CPU and RAM and was more than capable of running additional virtual machine workloads.

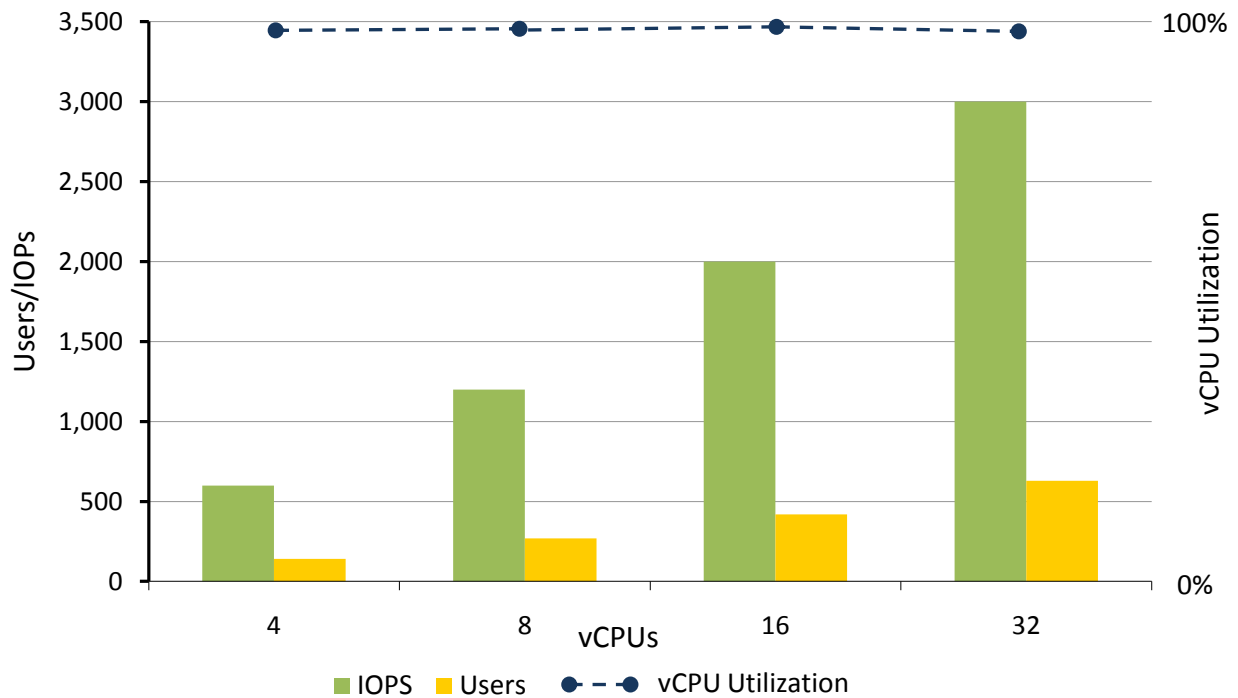
Performance and Scalability

ESG lab next ran the full workload simulation on the SAP ERP 6.0 server, starting with four vCPUs and scaling up to 32 vCPUs, capturing multiple key metrics such as the number of users, IOPS, vCPU utilization, and application response time as the workload was increased.

ESG Lab Testing

The number of users simulated, IOPS driven, and response time as well as the average CPU utilization while the workload was running were monitored as a scalable number of users were emulated on a single physical server virtualized with VMware vSphere 5. The results are summarized in Figure 8 and Table 1.

Figure 8. SAP ERP 6.0 Sales and Distribution Workload Scalability Using vSphere 5



Also shown in Table 1 are results captured using a 32-core physical machine ESG Lab tested in 2009⁴ using the same workload.

Table 1. VMware vSphere 5.0 and HP DL980 Workload Scalability

vCPUs	Users	Average vCPU Utilization	IOPS	Dialog Response Time (sec)
4	600	98.7 %	140	0.2
8	1,200	99 %	268	0.3
16	2,000	99.7 %	420	1.1
32	3,000	99.2 %	630	1.0
Physical Cores	Users	Average CPU Utilization	IOPS	Dialog Response Time (sec)
32	4,400	n/a	943	1.9

⁴ Configuration details can be found in the Appendix.

What the Numbers Mean

- A real-world OLTP ERP workload was emulated using SAP application and database servers running in one virtual machine.
- A single virtual machine scaled from 4 to 32 vCPUs as simultaneous SAP users were increased from 600 to 3,000, proving that SAP systems running on VMware can now easily scale as an environment grows to meet the needs of the largest SAP systems.
- Average CPU utilization was remarkably consistent through the entire range of tests, illustrating vSphere 5's ability to balance the load evenly across multiple cores and sockets as the size of the VM and the workload were increased.
- Dialog response time, representing the average application response time to users for all transaction types, ranged from .1 seconds to 1.1 seconds during the test for the virtual machines.
- ESG Lab compared these results with results obtained with a 32-core physical server tested using the same SAP configuration and transaction types and found that the vSphere virtualized HP ProLiant DL980, while driving approximately two-thirds of the users and IOPS of the tuned physical server, did so with half the dialog response time, which represents the delay users experience waiting for a transaction to complete.
- Considering that the SAP workload tested utilized only half of the CPU and one quarter of the available RAM installed in the DL980 tested, it is not unreasonable to expect that a single DL980 could easily support a second virtualized SAP workload at a similarly high utilization level and/or multiple less intensive workloads driven by other applications.

Virtual CPU utilization and dialog response time were monitored to confirm that vSphere 5 was distributing the load smoothly across all 32 vCPUs during testing and that transactions were being satisfied within accepted response time guidelines. Virtual CPU utilization was evenly distributed while transaction response time was low during the 4 vCPU test and remained low during the 8, 16, and 32 vCPU tests. The efficiency of VMware vSphere 5 running on a powerful HP ProLiant DL980 attached to a 1 GB iSCSI disk array with fast 15K RPM drives provided more than enough horsepower to support a very large and busy SAP server.

Why This Matters

ESG research indicates that performance is a top concern when implementing server virtualization. In fact, when asked to name the greatest barrier to more widespread deployment of virtualization for tier-1/data-intensive applications, performance was near the top of the list.⁵

Predictable performance scalability is a critical concern when complex applications with a mix of workloads share a system's resources. A burst of processing or IO activity in one area (e.g., a database consistency check) can lead to poor response times, lost productivity, and, in the worst case, lost revenue. Virtualized tier-1 applications can potentially present the most diverse mix of application types and IO access patterns a single server may encounter.

ESG Lab found that the HP ProLiant DL980, powered by Intel Xeon processors and virtualized with VMware vSphere 5, was able to provide throughput-intensive and response-time sensitive performance similar to an enterprise-class physical server ESG Lab tested using the same workloads.

ESG research further validates the value of deploying SAP in a virtualized environment, with 39% of respondents having already deployed database software (i.e., Oracle Database Standard Edition, Microsoft SQL Server, MySQL, etc.) and an additional 49% having plans or interest in deploying on production virtual machines.

⁵ Source: ESG Research Report, [The Evolution of Server Virtualization](#), November 2010.

ESG Lab Validation Highlights

- ☑ An HP ProLiant DL980 physical server, running a tier-1 SAP ERP 6.0 implementation deployed within one VMware vSphere 5 virtual machine, scaled nearly linearly in performance as vCPUs and memory were increased—up to a total of 32 vCPUs in a single virtual machine.
- ☑ CPU utilization and response times remained low throughout testing, indicating significant headroom to support larger workloads with increased storage bandwidth and system tuning.
- ☑ A sustained CPU-intensive workload was evenly distributed across all 32 vCPUs in the virtual machine.

Issues to Consider

- ☑ While the scalability of both vSphere 5 and the ProLiant DL980 server are extensive (up to 1 TB per VM, 2 TB per host server), the tests ESG is validating were done without taking full advantage of the capabilities of this combination solution, using only 512 GB of memory in the server. ESG believes the performance of VMs with maximum allocations of memory running on the platform will be consistent with the results validated in this report.
- ☑ Capacity planning and performance analysis of SAP deployments is recommended to not only determine if your organization's workload is suitable for virtualization, but also to plan the processor, memory, storage, and network resources that need to be configured within each virtual machine.
- ☑ SAP application and database server roles are both good candidates for virtualization. For database implementations at the very high end (ie:32 vCPUs in a single virtual machine), users would be well-advised to consider deploying application servers on virtual machines separate from resource-intensive database instances.
- ☑ The test results presented in this report are based on a simulated workload deployed against an SAP ERP 6.0 installation in a controlled environment. Due to the many variables in each production data center environment, capacity planning and testing in your own environment is highly recommended. Sizing SAP deployments is always under the purview of the hardware partner; work with your HP team for sizing, performance, and capacity planning.
- ☑ Default server BIOS, operating system, SAP, and SQL Server settings were used during ESG Lab testing. As expected after any performance test of this magnitude, analysis of the results indicates that tuning would probably yield higher absolute results. Given that the goal of this test was not to generate a big number, ESG Lab is confident that the results presented in this report demonstrate the performance and scalability of tier-1 application workloads running in consolidated VMware vSphere 5 environments.

The Bigger Truth

Server virtualization is being deployed by a large and growing number of organizations with the ambitious, parallel goals of lowered costs, improved resource utilization, non-disruptive upgrades, and increased availability. Each of these benefits is fundamentally enabled by decoupling servers, applications, and data from specific physical assets—bringing IT organizations one step closer to the ideal of a completely virtualized IT infrastructure. A recent ESG survey indicated that increasing the use of server virtualization was users' number one IT priority over the last two years and will continue to be the top priority for the next 12-18 months. But while server virtualization continues to gain momentum, some IT organizations are still reluctant to fully embrace virtualization.

It's a common strategy for organizations to focus server virtualization efforts on consolidation until they build the confidence and expertise to consider the next tier of applications; ESG found that 59% have yet to employ virtualization where it will provide the most benefit: their data-intensive tier-1 applications. For IT organizations supporting large numbers of users, this hesitance stems from the perception that it adds performance overhead and unpredictable scalability and availability challenges to the tier-1 applications relied upon by the majority of their users.

Multiple vendors currently offer server virtualization solutions and the field continues to expand. Choosing a solution set to best fit a specific environment, business need, or budget can be a significant challenge. HP, Intel, and VMware answer this challenge with massively scalable server platforms built on powerful, virtualization-optimized processors and robust, scalable, easy-to-use virtualization software which integrates seamlessly with HP server management software such as HP Insight Control for ProLiant.

The HP ProLiant DL980 platform is a dense, scale-up industry-standard server powered by the latest Intel Xeon processor technology and designed to support the largest and most challenging virtualized applications and workloads with the added goal of fast, easy deployments that users can customize to grow computing power in the data center on demand.

VMware vSphere 5 virtualizes servers with the goal of transforming traditional x86-based IT infrastructure into an automated, always-on computing environment. Customers have reduced IT infrastructure costs while streamlining management of IT environments and delivering improved service levels to the business. vSphere 5 builds on the robust tools and capabilities of VMware, including the capability of creating virtual machines with up to 32 virtual CPU cores and true NUMA functionality, while VMware High Availability and Fault Tolerance capabilities integrate tightly with HP to offer business continuity.

ESG Lab hands-on testing has confirmed that HP, Intel, and VMware technology can be used to meet the performance and scalability requirements of virtualized tier-1 workloads. Predictably low response times and near linear performance scalability were achieved during testing as a single server hosting a virtualized SAP ERP deployment within one vSphere 5 virtual machine supported up to 3,000 simulated SAP users. Extremely low application response times were observed in an un-tuned environment, implying significant headroom to support more users when the environment and application are tuned for performance. Considering the large amount of unused resource capacity in the DL980 under test, ESG Lab believes that a single DL980 could easily support a second virtualized SAP workload at a similarly high utilization level and/or multiple less intensive workloads driven by other applications.

Virtualizing SAP and other tier-1 applications' workloads with the HP ProLiant DL980, powered by Intel Xeon processors in combination with vSphere 5, enables businesses to overcome scalability and performance concerns as they lower costs and increase the agility and availability of a consolidated IT infrastructure. With the ability to host multiple, large-scale virtual machines with very large memory footprints inside a single physical server, administrators can support a very large tier-1 application environment in a very small data center footprint.

It's clear to ESG Lab that the complementary technologies offered by HP ProLiant DL980 servers, Intel Xeon processors, and VMware vSphere 5 virtualization software can be used to effectively support vital enterprise workloads like SAP, providing the reliability and performance customers require while simplifying operations, lowering costs, and providing tier-1 class availability—all in a virtualized x86 environment.

Appendix

Table 2. ESG Lab Test Bed

Software	
Hypervisor	VMware vSphere 5: RTM build 441354
Application	SAP ERP 6.0
Guest OS	Windows Server 2008 R2, Data Center Edition (64-bit), SP1, version 6.1.7601
Database	Microsoft SQL Server 2008 R2, Data Center Edition (64-bit), version 10.50.1600.1
Hardware	
Server	HP ProLiant DL980 with 8x 2.26 GHz Intel Xeon X7560 8-way CPUs and 512 GB RAM
Storage	HP P4500 SAN G2 with 36 15K RPM SAS drives
SAN	1 Gbps iSCSI
Workload Generator	
Virtual Machine	
SAP ERP 6.0	Windows Server 2008 R2, 4-32 virtual CPUs, 1-4 virtual NUMA sockets, 16-128 GB RAM
Physical Machine (2009)	
SAP ERP 6.0	Windows Server 2003, 16 Intel Xeon 7041 3GHz dual-core CPUs, 128 GB RAM Disk Subsystem: 48 10K RPM FC drives, 4Gbps FC SAN



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