SAP Performance on vSphere with IBM DB2 and SUSE Linux Enterprise

VMware vSphere 4.1 with SAP ERP 6.0, IBM DB2 9.7, and SUSE Linux Enterprise 10

VMware vSphere™ 4.1 provides private cloud technology to IT organizations looking to save money on hardware costs, offer their companies a software-as-a-service (SaaS) model, and guarantee uptime while maintaining and upgrading their software applications and infrastructure.

This paper shows how a virtualized SAP environment with IBM DB2 and SUSE Linux Enterprise can support thousands of users by utilizing VMware vSphere 4.1. The results collected with vSphere 4.1 out-of-the-box showed excellent scale-up and scale-out performance.

- **Scale-up:** Scaling up a virtual system refers to adding virtual CPUs (vCPUs) to increase a virtual machine's compute power. With vSphere, your virtual machine can easily take advantage of multi-core processors with no special settings or configuration beyond building up the virtual machine with more vCPUs.

- **Scale-out:** Scaling out a virtual system refers to adding more virtual machines on the host.

VMware vSphere makes it easy to combine scaling up with scaling out to achieve the optimum performance for your VMs. And having the choice to scale up or out leaves you with more flexibility to right-size system deployment and maximize total cost of ownership with respect to licensing and hardware purchases.

Experimental Environment

We ran SAP ERP 6.0 Enhancement Package 4 and IBM DB2 version 9.7 with SUSE Linux Enterprise 10 SP2 as the operating system. The hardware was a 16-core Dell PowerEdge R905 machine running VMware vSphere 4.1. The AMD Opteron 8384 processors in this server use Rapid Virtualization Indexing (RVI), which makes them well-suited for virtualizing a memory-intensive workload like SAP. The SAP application and database servers were tuned according to SAP and IBM DB2 performance best practices. The experiments were conducted in good faith, but the results in this paper have not been certified by SAP.

Workload

Our tests used a well understood online transaction processing (OLTP) workload, which simulates typical customer transactions. The results from these tests can be used as a guideline for determining the performance outlook for new hardware and software platforms.

As part of the test design, we used a two-tier approach that has both application and database servers on the same virtual machine. This is a popular configuration for small- to mid-sized SAP installations. A separate physical system (the load generator) was used to simulate the users in the presentation tier.

The number of users for each test was determined by measuring how many users could be actively simulated while the response time was still under 1 second.

Software and Hardware

Figures 1 and 2 show the system configuration that we used for our scale-up and scale-out tests. For these tests, we ran the database and application tier on the native machine first, and then installed and configured the machine with VMware vSphere 4.1 to run the database and application tier in 1 virtual machine (scale-up test) and up to 8 virtual machines (scale-out test).
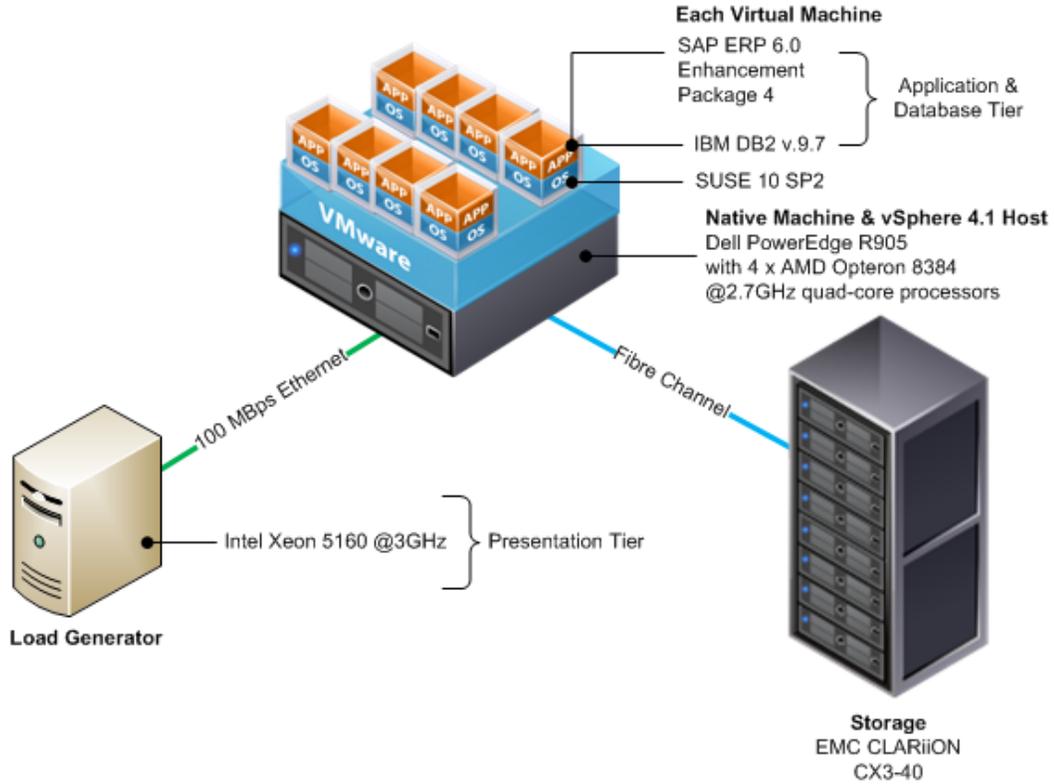
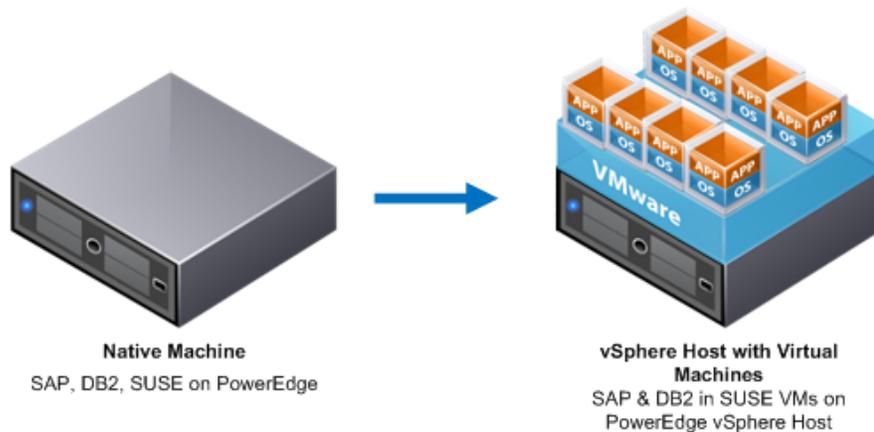**Figure 1.** Test architecture

Figure 2. We ran tests on the native machine, installed vSphere, and then ran tests on virtual machines

Infrastructure and application software:

- VMware vSphere 4.1

- SUSE Linux Enterprise 10 SP2 guest operating system

- SAP ERP 6.0 Enhancement Package 4

- IBM DB2 Version 9.7

SAP database and application server:

- Dell PowerEdge R905 with 4 x AMD Opteron 8384 2.7GHz quad-core processors

- 256KB L1 cache, 2MB L2 cache, 6MB L3 cache

- 128GB physical memory

- Virtual machines (8): 16GB memory and 2 or 4 vCPUs

- SAP instances: 1 instance per 2 vCPUs

Storage:

- 4 EMC CX3-40 storage array enclosures, with Fibre Channel and 2 storage processors

- Each array enclosure has 15 disks, and each disk is 146GB, for a total of 2,190GB of combined storage.

- 10 data and log LUNs were configured as RAID 0 (striped):

    - 8 LUNs over 2 SAN disk array enclosures (each LUN striped over 15 disks) used for database files; 8 SAP DATA files

    - 1 LUN for the database log file, located on a separate array enclosure

    - 1 LUN for the heavily updated database table VBDATA, located on a separate array enclosure to avoid I/O bottleneck

Load generator:

- Intel Xeon 5160 3GHz dual-core processor

- 8GB memory

- 19GB local root disk

- Microsoft Windows Server 2008 operating system

Scale-Up Test for Transaction Processing Workload

Our scale-up test compares a single virtual machine with a matching native machine. Each was scaled up with tests at 1, 2, 4, and 8 virtual CPUS (vCPUs) or physical CPUs[1]. Figure 3 depicts this test scenario.

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[1] A system with 1 vCPU, 2 vCPUs, 4 vCPUs, or 8 vCPUs is also known as a 1-way, 2-way, 4-way, or 8-way system.

Figure 3. The scale-up test measured performance after adding CPUs
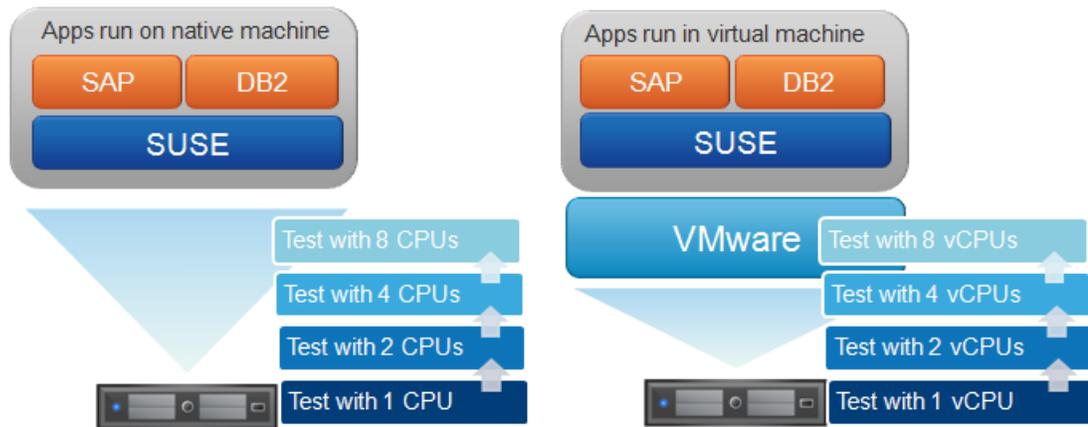
The virtual machine and the native machine were both tested on the same system, which had 4 quad-core AMD Opteron 8384 2.7 GHz processors and 128GB of RAM. This system uses a NUMA architecture, which means that memory is associated with each processor to define a node.

The NUMA load balancer in vSphere assigns a home node to a virtual machine. Whenever possible, the NUMA load balancer in vSphere tries to keep a vCPU with its local memory, but if the VM requires more memory than is present on its home node, remote memory might be used. To ensure locality, we assigned the virtual CPUs in the same way that we assigned the physical CPUs. The assignment of CPUs to memory homes is illustrated in Figure 4.

When conducting experiments on the native machine running Linux, we used `numactl` to assign CPUs to the same nodes that were used for the virtual machine tests. For tests with 1-4 CPUs, we assigned the CPUs to the same node so that the workload could benefit from accessing the local memory. For 8 CPUs, we assigned the CPUs to 2 nodes.

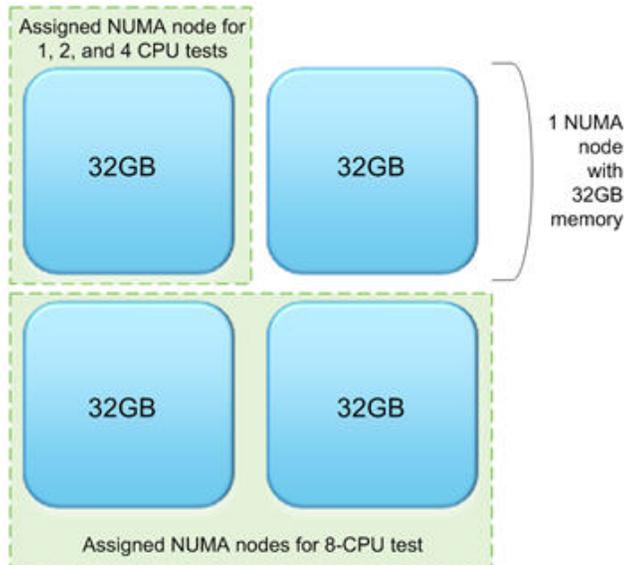**Figure 4.** NUMA nodes were assigned to CPUs to ensure local memory was used

Figure 5 shows that virtual performance is near native when scaling up for these tests. Additionally, virtual machine performance is slightly better when using VMs with fewer vCPUS.

Figure 5. Number of users supported while scaling up virtual and physical CPUs
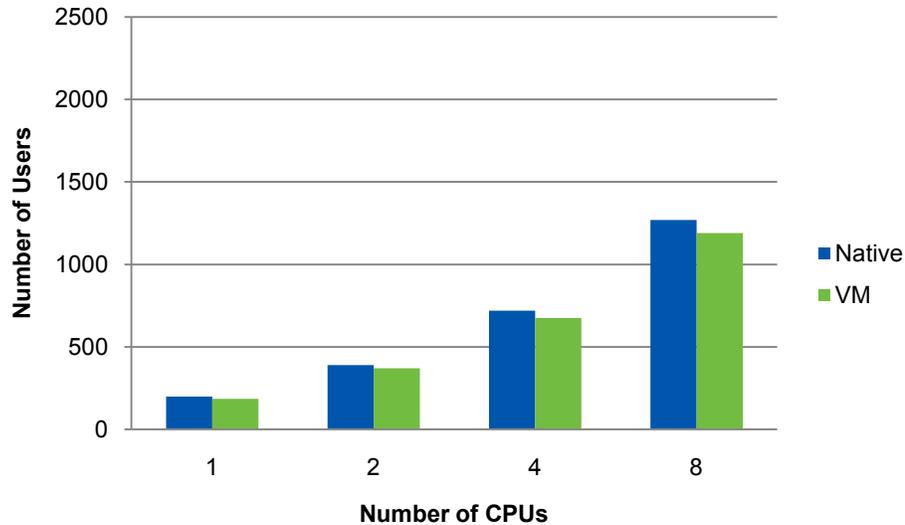

Table 1 shows the ratio of supported users on the tested virtual machines to the tested native machines. The ratios range from a difference of only 93%-95%.

Table 1. Ratio of supported users (virtual ÷ native)

Virtual CPUs	vSphere 4.1 Ratio to Native
1	93%
2	95%
4	94%
8	94%

Scaling up VMs is useful when it is necessary to keep licensing costs very low or keep the number of VMs to a minimum due to limited system administration resources. With near native performance, vSphere gives IT professionals the choice of switching to a virtualized environment to maintain a small to mid-sized SAP installation on SUSE 10 with DB2.

Scale-Out Test with Multiple Virtual Machines

For scale-out performance, we conducted six tests to compare a series of VMs with similar, increasing levels of compute power. Figure 6 shows how three 4-way VMs provided a comparison with three 2-way VMs.

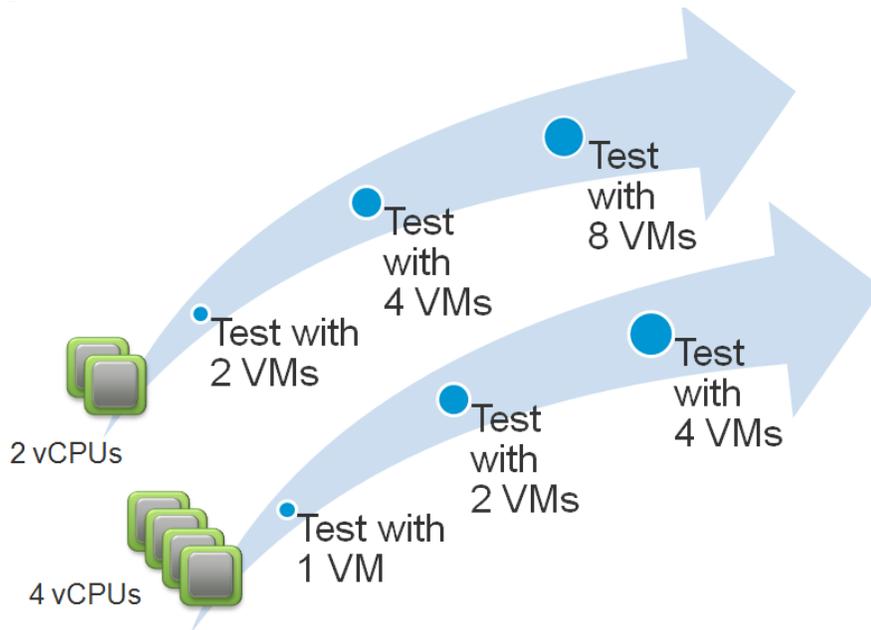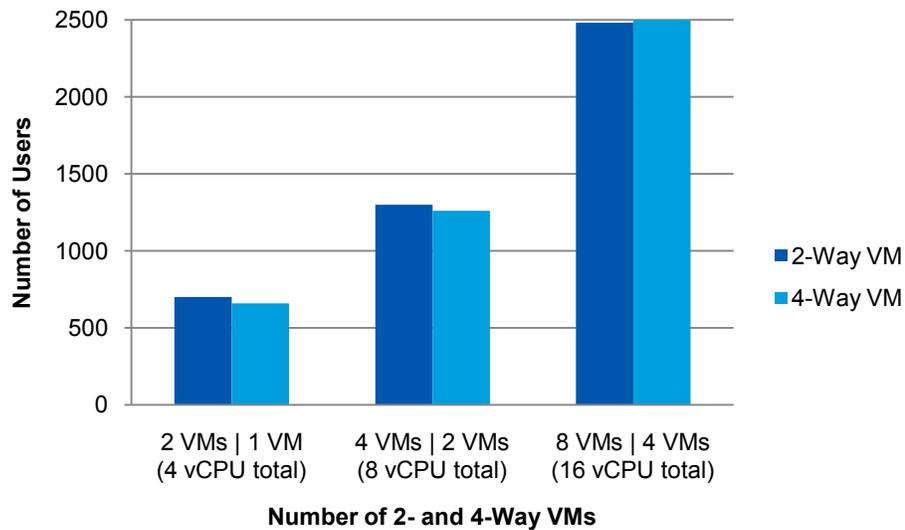**Figure 6.** We ran tests with 2-vCPU and 4-vCPU VMs

Figure 7 shows the number of users supported by VMs with similar processing power. Each pair of VMs is configured with the same total number of vCPUs. For example, 2 VMs each with 2 vCPUs are compared with a single 4-vCPU VM.

Figure 7. Scale-out test with both 2- and 4-way VMs

The performance of 2-way and 4-way VMs is very similar. This similarity allows administrators flexibility in designing their SAP solutions. We also see that scaling out to multiple VMs is an effective way to handle the need for more processing power.

Conclusion

vSphere 4.1 easily supports a demanding SAP ERP installation by allowing administrators to either scale up or scale out. In our experiments, an 8-way virtual machine was employed to support a target user base of approximately 1200 users, achieving very nearly the same number of users as a similar native test. vSphere 4.1 can also be scaled out to support larger user workloads as shown by our result of 2500 users which were supported with 16 vCPUs. Using multiple virtual machines, each assigned multiple vCPUs, leverages multi-core technology in a way that results in great performance and scalability.

Related Documents

"Virtualized SAP Performance with VMware vSphere 4." VMware whitepaper.
http://www.vmware.com/files/pdf/perf_vsphere_sap.pdf

About the Author

Tuyet Pham is a performance engineer in VMware's Core Performance group where she is responsible for characterizing the performance of SAP on Windows and Linux. Her work on the subject of virtualizing the SAP landscape appears in previously published performance studies and best practice documents.

Prior to VMware, she was a performance engineer at Hewlett-Packard, where she worked with OLTP benchmarks such as TPC-C and TPC-DS, and SAP Standard Application benchmarks.

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