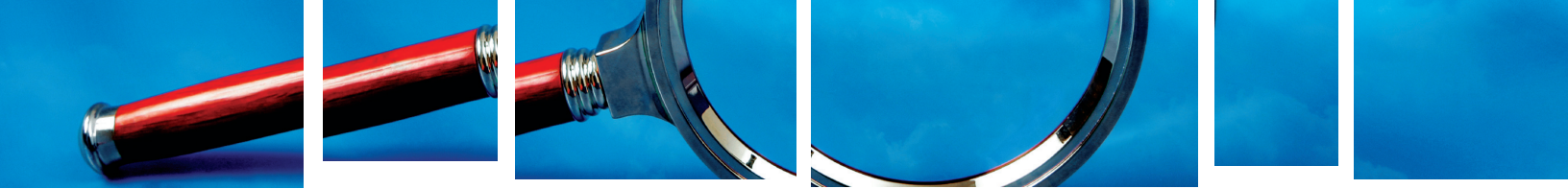


UniCloud Virtualization Benchmark Report

**Summary of Univa Lab and Application Performance Metrics
Using Nehalem Generation Intel® Microarchitecture**

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INTRODUCTION

In the past, most applications and workloads in a virtualized environment ran 30 percent to 35 percent slower than in a physical compute infrastructure. This performance toll varies depending on a range of potential factors: application type, type of workload being executed, whether the workload is processor-bound or I/O-bound, how data-intensive the workload is, and many more.

The goal of this white paper is to document the performance variation introduced through the use of virtualization and to challenge the popular view that technical computing and virtualization do not co-mingle. The paper describes a series of application benchmarks run both by end users in a customer production environment and by internal engineers in Univa UD's labs in Chicago. The tests were performed running Oracle VM in paravirtualized mode along with Univa's UniCloud 2.0 utilizing Nehalem generation Intel® microar-

chitecture and Intel® Xeon® 5400 series processors running some of the most popular electronics design automation (EDA) applications from Cadence, Synopsys, Apache and Magma.

The benchmarks presented in this report are from end users who openly shared the results of running their applications in a virtualized environment. The

tests, run on Oracle VM production systems utilizing Intel processors, have delivered startling results that clearly reveal the performance slowdown from virtualization overhead to be, in many cases, marginal. The benefits for businesses, however, are powerful and real.

Lab tests include:

- SuperPi
- NAS Parallel Benchmarks – Open MP
- NAS Parallel Benchmarks – Serial
- Stream Benchmark
- Iperf network performance

Customer applications in this study include:

- Synopsys HSIM
- Synopsys PrimeTime
- Synopsys Design Compiler
- Apache RedHawk
- Magma
- Cadence UltraSim

ABOUT UNICLOUD

UniCloud is a cloud management software product that delivers unique capabilities for enabling private, public and hybrid cloud computing environments. UniCloud delivers policy-enabled dynamic resource management, so users' highest-performance (and highest-value) applications are optimally utilized across a pool of shared virtual and physical resources. In such an environment, jobs are always run on the most eligible resource available and can be live-migrated, checkpointed, or sent to a data center or external cloud with zero downtime and no end-user impact. As a result, users can maximize software license optimization, throughput and resource utilization while reducing costs.

Companies use UniCloud to form an elastic compute infrastructure or cloud environment that unifies provisioning, configuration, workload and virtualization management with application configuration



The collected results show an average 2% slowdown, with several CPU and memory intensive applications actually running between 2% and 4% faster in a VM.



Conclusions from lab tests were very clear: Memory and CPU intensive applications perform extremely well in virtualized environments using UniCloud and Nehalem generation Intel® microarchitecture, even showing performance improvements over bare metal in some cases.

into a single Web-services-based framework. By integrating this flexible, powerful framework with management of resources and policies, UniCloud greatly simplifies the deployment and operation of both physical and virtual (i.e., “dual-mode”) compute infrastructures.

UniCloud integrates a policy engine that enforces infrastructure and application-based SLAs, Sun Grid Engine (SGE) software and a powerful infrastructure-provisioning framework to dynamically add virtual or physical compute resources to the infrastructure, automatically delivering real-time resource optimization based on available memory, licenses, power consumption, CPUs and even data locality.

UniCloud features software profiles, composed of

a software stack and configuration information called Kits, which are provisioned on hardware profiles. UniCloud supports bare metal, Intel® processors, and public cloud hardware profiles such as Amazon EC2 and Rackspace. A unique feature is the ability to provision a software Kit to any supported hardware profile enabling mobility and automation — that is, it is possible to reprovision an on-premises Kit to Amazon EC2 (for example) without changing the Kit. UniCloud also greatly simplifies software image creation and management.

ABOUT NEHALEM GENERATION INTEL® MICROARCHITECTURE

First available in November 2008, the 45nm Intel® Core™ i7 processor based on Intel microarchitecture, codenamed Nehalem, represents a big step forward in faster, multi-core technology that intelligently maximizes performance to match workload. Designed to take advantage of advances in 45nm hafnium-based hi-k metal gate transistors and related manufacturing technology, Nehalem-based products unleash energy-efficient parallel processing performance using an integrated memory controller.

UniCloud Cloud Management Software

UniCloud Capability	Description
Policy Management	Integrated policy management makes connecting workload placement to business priorities a snap. Migrating, moving, check-pointing, starting and stopping workload is fast and easy.
Workload Management	Built around powerful Sun Grid Engine software for advanced and high-throughput needs.
Configuration Management	Automated installation and configuration of physical and virtual compute environment.
Provisioning	Advanced dual-mode (physical and virtual machine) supported. Adapters for various internal or external provisioning environments (bare metal, OVM, public clouds). Automates expansion to and software management of cloud services like Amazon EC2, Rackspace etc.
Automation and Mobility	Building and rebuilding images in the cloud is automated. Moving software stacks from physical to virtual or across VMs or cloud providers is automated and simple.

Intel® microarchitecture codenamed Nehalem offers the latest in processor innovation, including:

- **Dynamic scalability**, managed cores, threads, cache, interfaces, and power for energy-efficient performance on-demand.
- **Design and performance scalability** to address servers, workstations, notebooks, and desktop segments with support for two to eight or more cores and up to 16 or more threads with Intel® Hyper-Threading Technology (Intel® HT Technology¹) and scalable cache sizes, system interconnects, and integrated memory controllers.
- **Intelligent performance on-demand** with Intel® Turbo Boost Technology² taking advantage of the processor’s power and thermal headroom. This enables increased performance of both multi-threaded and single-threaded workloads.

For more information about UniCloud, visit <http://www.univaud.com/products>.

¹ Intel® Hyper-Threading Technology (Intel® HT Technology) requires a computer system with an Intel® processor supporting Intel HT Technology and an Intel HT Technology-enabled chipset, BIOS, and operating system. Performance will vary depending on the specific hardware and software you use. See www.intel.com/products/ht/hyperthreading_more.htm for more information including details on which processors support Intel HT Technology.
² Intel® Turbo Boost Technology requires a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software, and overall system configuration. Check with your manufacturer on whether your system delivers Intel Turbo Boost Technology. See www.intel.com/technology/turboboost/ for more information.



“Data center managers need not be concerned with the 30% to 35% virtualization penalty anymore. This white paper clearly demonstrates that utilizing UniCloud running on the latest Intel hardware and Oracle VM Server renders the dreaded virtualization overhead virtually nonexistent.”

– Gary Tyreman, SVP of Products and Alliances, Univa UD

- **Increased performance on highly-threaded applications** with Intel® HT Technology, bringing high-performance applications into mainstream computing with one to 16+ threads optimized for this new multi-core processor architecture.
- **Scalable shared memory** for specific servers and workstations features memory distributed to each processor with integrated memory controllers and Intel QuickPath Technology high-speed point-to-point interconnects to unleash the performance of configurations of multiple multi-core processors based on Intel® microarchitecture codenamed Nehalem.
- **Multi-level shared cache** improves performance and efficiency by reducing latency to frequently used data.

With faster, intelligent, multi-core technology that applies processing power where it’s needed most, the new Nehalem-based Intel® Core™ i7 processors deliver an incredible breakthrough in desktop processor performance. Core i7 includes a combination of Intel® Turbo Boost technology and Intel® Hyper-Threading technology (Intel® HT technology), which maximizes performance to match workload.

For more information on Intel® Nehalem processors, visit <http://www.intel.com/technology/architecture-silicon/next-gen/>

ABOUT ORACLE VM

Oracle VM is server virtualization and management software that makes enterprise applications easier to deploy, manage and support, and fully supports both Oracle and non-Oracle applications; it also delivers more efficient performance. Users can create and manage virtual machines (VMs) that exist on the same physical server but behave like independent physical servers. Each virtual machine created with Oracle VM has its own virtual CPUs, network interfaces, storage and operating system. With Oracle VM, users have an easy-to-use browser-based tool for creating, cloning, sharing, configuring, booting and migrating VMs. It also

provides features such as power on, power off, deleting, importing, deploying, and live migration of virtual machines.

Backed by Oracle’s world-class 24x7 global support organization, customers now have a single point of enterprise-class support for their entire virtualization environments, including Oracle Database, Fusion Middleware, Applications and Linux, which are certified with Oracle VM.

Oracle VM Templates deliver rapid software deployment and eliminate installation and configuration costs by providing preinstalled and preconfigured software images. Oracle is the only software vendor to combine the benefits of server clustering and server virtualization technologies, delivering integrated clustering, virtualization, storage and management for grid computing.

For more information on Oracle VM, visit http://download.oracle.com/docs/cd/E15458_01/doc.22/e15443/toc.htm

APPLYING VIRTUALIZATION TO TECHNICAL COMPUTING

At the time this study was undertaken, the technical computing industry as a whole had essentially dismissed the use of virtualization for primarily two reasons. First, since compute grids were already seeing high utilization rates, the core value proposition of consolidation through virtualization didn’t apply. Second, the popular thought was that the overhead would degrade performance as much as 30 percent to 35 percent.

The value of virtualization in technical computing does not begin and end with utilization gains. In fact, any gains in utilization are a by-product of the primary value: mobility and leveraging cloud computing. The new and innovative workload management capabilities derived from mobility, the result of abstracting the software from the hardware, include:

- Re-balancing (live migrating) workload based on priorities
- Re-sizing a virtual machine to avoid swapping
- Checkpointing with a virtual machine snapshot
- Adapting physical and virtual resources on demand to meet current and changing priorities

The idea that job scheduling no longer remains a “fire and forget” option is a profound paradigm

shift in fundamental compute environment management principles. Virtualization is a precursor to leveraging cloud computing for any large user of compute-based simulation, science and research, and it is probably more profound than the change affected by commodity computing and workload management more than 10 years ago.

NEW MANAGEMENT AS A RESULT OF VIRTUALIZATION

Policy-Driven Resource Management

Traditional cluster computing environments are essentially built once and managed into retirement or replacement. Job schedulers in this context offer the valuable service of sharing a finite set of resources with a large number of users (or with the workload they generate). The decisions a scheduler makes at any point in time are “best case,” and the dispatching of workload is straightforward.

However, as more workload is submitted, priorities across the entire system are likely to change. Resource assignments can change but only through brute force — the killing of running jobs. This practice is quite common, as is doing nothing or essentially “letting things ride.”

Both of these practices are inefficient and introduce waste and delay.

Policy-driven resource management is a by-product of the mobility introduced with virtualization. Need a resource to run a priority job? Make it available. How? Move the job that is consuming the resource or suspend it. Need to change the operating system or memory size, or to flip back to bare metal for a particular job? Done. UniCloud uniquely supports these needs and was specifically designed for such advanced situations. UniCloud tightly couples workload management, resource management and provisioning systems to create a new class of systems management. UniCloud can not only move workload within a data center but can also extend or burst into a public cloud and add managed capacity on demand.

Live Migration

Live migration is a core function of the hypervisor and is well practiced in the data center where virtualization is common. In technical computing environments, this function underpins the advantages of a dynamic computing environment. The ability to

move workload around allows further optimization of expensive resources and practically eliminates the waste by introducing options to administrators: rather than kill and resubmit a job, move it, suspend it or resize the VM.

Checkpointing

Hypervisors support snapshots. Checkpointing the entire “machine” and saving the image (with all of the data, memory and file handles, etc.) to network attached storage is simple and trustworthy. Long-running jobs can be effectively checkpointed — a very valuable capability for jobs that run for months— helping to avoid lost time and get to results and market faster.

Swap Reduction

There are times when jobs require more memory than what was initially allocated. When this happens, the machine will traditionally swap memory to disk, which significantly degrades performance across all jobs on the resource. By contrast, with virtualization, a VM’s memory size can be resized on the fly as long as there is enough physical memory available to do so. If there isn’t enough memory available on the machine, either because of other VMs or due to physical limits, UniCloud will move VMs to rebalance the memory requirements. This operation may involve moving and resizing the VM causing the swapping or one or more of the VMs sharing the resource. The decision will always be one that has the least impact on throughput — for example, moving an 8GB VM may take several seconds, while moving a 64GB VM could take minutes. Instead of moving the large VM, UniCloud can suspend it and then restart it on another server — an operation that is significantly faster and more effective.

Persistent Workload Rebalancing

UniCloud policy management constantly monitors Sun Grid Engine and ensures that current workload priorities are enforced. To do so, UniCloud leverages virtualization to match workload to the best resource and to make available the best resource in the case of contention. In this manner, UniCloud will persistently rebalance the workload across the compute cluster and even across public clouds when bursting is required.

Playing the game of “workload Tetris” has never been so optimized or powerful.



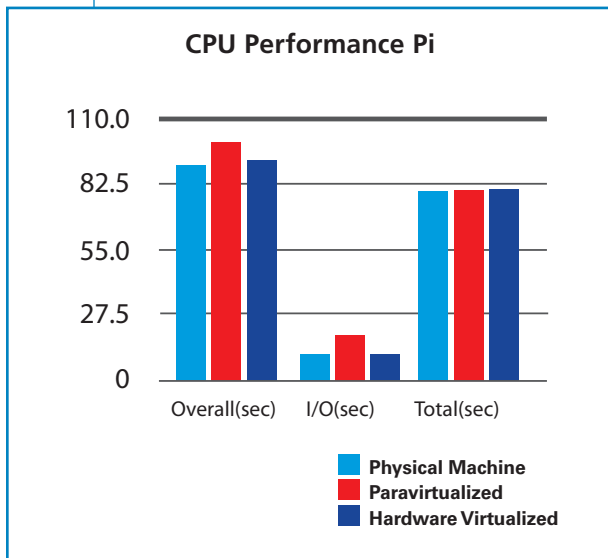
UniCloud with virtualization establishes several options beyond simply choosing to suffer or kill jobs. The ability to provision exactly the same software profile across multiple hardware profiles is powerful and unique. Moving a server from bare metal to hypervisor-enabled is quick, simple and automated. Moving a software profile from physical to virtual to cloud is also fully supported.

Dual-Mode Support

Certain applications require bare metal (no hypervisor), and for this purpose UniCloud offers simultaneous dual mode support. The ability to provision exactly the same software profile across multiple hardware profiles is powerful and unique. Moving a server from bare metal to hypervisor-enabled is quick, simple and automated. Moving a software profile from physical to virtual to cloud is also fully supported.

LAB BENCHMARKS

Univa engineers benchmarked UniCloud 2.0 on servers using the Intel Nehalem Core i7 processor series running Oracle VM software in their Chicago labs. These tests were designed to gauge the results of bare metal (physical machine) performance against both paravirtualized and hardware virtualized machines. The engineers at Univa Labs also wanted to understand the characteristics of each application type: CPU intensive, memory intensive, I/O intensive, and network intensive. This would establish guidelines for application profiles and their suitability for the cost/benefit of virtualization, as well as guide architecture design for best performance.



The Univa lab testing environment included the following technology:

- Two machines with Intel® Desktop Board DX58SO (integrated Gigabit Ethernet)
 - Intel® i7-920 2.66GHz Quad-Core processor with Crucial 6GB (3x2GB) 240-pin DDR3 1333 triple-channel memory
 - Hitachi HDS725050KLA360 7200 RPM 500GB SATA Drives
 - Intel® 82567LM Gigabit Ethernet Controller
- Virtualization
 - Oracle Virtual Machine (OVM 2.2.0 current shipping version) with latest updates

Paravirtualization

Paravirtualization is a hypervisor virtualization technique that splits the virtualization layer into two pieces. One piece provides an almost complete virtual hardware interface to any virtual machine running on the hypervisor and the other piece provides special hooks into the underlying hardware. A virtual machine running on the hypervisor must be modified slightly, to run paravirtualized. Typically the native hardware drivers are replaced with paravirtualized drivers. These special drivers use the hooks provided by the paravirtualization layer to speed up critical tasks, such as network and disk I/O, delivering better performance in the virtual machine. The guest OS, or OS running in the virtual machine must be modified to run in a paravirtualized environment. An unmodified OS cannot run paravirtualized and requires full hardware virtualization to run as a virtual machine.

Networking is an example of where paravirtualization might be used for performance. The virtual monitor can present the guest operating system with an intelligent NIC with support for DMA-based sending of packets, even though the NIC on the real (host) system lacks this capability. Sending packets is then done entirely by the virtual monitor, and NIC interrupts may be processed by the monitor, too. Since delivering interrupts to the guest operating system is expensive, performance will improve.

Benchmark: CPU Performance (Pi)

To benchmark the CPU overhead of Oracle VM, Univa used Super Pi, a computer program that calculates pi to a specified number of digits after the decimal point — up to a maximum of 32 million. Super Pi is commonly used to benchmark the CPU. Since it easily swamps a CPU, it can be used as a stress test and an indicator of virtualization overhead to CPU-intensive applications.

This test was performed using Intel® Core2 Quad Q6600 CPUs because the Intel Nehalem core i7 processors executed the test so quickly that it was impossible to get a high CPU load.

The results very clearly show that virtualization, both hardware and paravirtualized, introduces no degradation for CPU intensive applications. In fact, Oracle VM in paravirtualized mode outperformed bare metal.

Benchmark: CPU Performance (NPB)

Univa also ran NAS Parallel Benchmarks in serial mode to ensure that the CPU performance seen with Super PI was not an anomaly. These tests were run using Intel Nehalem Core i7 series processors.

As of NPB 3.3, eleven benchmarks are defined as summarized in the table below.

NAS Parallel Benchmarks⁽³⁾

Benchmark	Name Derived from	Available Since	Description
MG	MultiGrid	NPB 1	Approximate the solution to a three-dimensional discrete Poisson equation using the V-cycle multigrid method
CG	Conjugate Gradient		Estimate the smallest eigenvalue of a large sparse symmetric positive-definite matrix using the inverse iteration with the conjugate gradient method as a subroutine for solving systems of linear equations
FT	Fast Fourier Transform		Solve a three-dimensional partial differential equation (PDE) using the fast Fourier transform (FFT)
IS	Integer Sort		Sort small integers using the bucket sort
EP	Embarrassingly Parallel		Generate independent Gaussian random variates using the Marsaglia polar method
BT	Block Tridiagonal		Solve a synthetic system of nonlinear PDEs using three different algorithms involving block tridiagonal, scalar pentadiagonal and symmetric successive over-relaxation (SSOR) solver kernels, respectively
SP	Scalar Pentadiagonal		
LU	Lower-Upper symmetric Gauss-Seidel		
UA	Unstructured Adaptive	NPB 3.1	
DC	Data Cube operator		
DT	Data Traffic	NPB 3.2	

³The NAS Parallel Benchmarks (NPB) are a set of benchmarks targeting performance evaluation of highly parallel supercomputers. They are developed and maintained by the NASA Advanced Supercomputing (NAS) Division (formerly the NASA Numerical Aerodynamic Simulation Program) based at the NASA Ames Research Center. The .A, .B, .C, etc. represents various classes of the NPB tests with higher alphabet representing more complex calculations.



The key takeaway is that memory-intensive applications will not degrade. Therefore, we should expect very good performance.

Univa focused on the “B” class tests, which are longer-running benchmarks, in order to load the Intel Nehalem processors for an extended period of time. The benchmarks were run five times each, and the results were averaged.

The OpenMP benchmark demonstrated that virtualization overhead was almost non-existent. The OpenMP benchmark demonstrated that virtualization overhead was almost non-existent, as presented in the tables on page 9.

Benchmark: Memory Performance

The STREAM benchmark was used for memory performance; it measures the ability to push data through memory, in MB per second. Performance was essentially consistent between physical and virtualized machines, with paravirtualization showing improved performance consistent with the memory-intensive application results shown earlier.

Univa ran these tests using servers powered by the Intel Core2 Quad Q6600 machines as well as Core i7 series processor based machines. The machines powered by the Nehalem-based Core i7 series processors proved to be 120 percent

faster than the Intel Core2 Quad Q6600 based machines for memory throughput.

What Is STREAM?

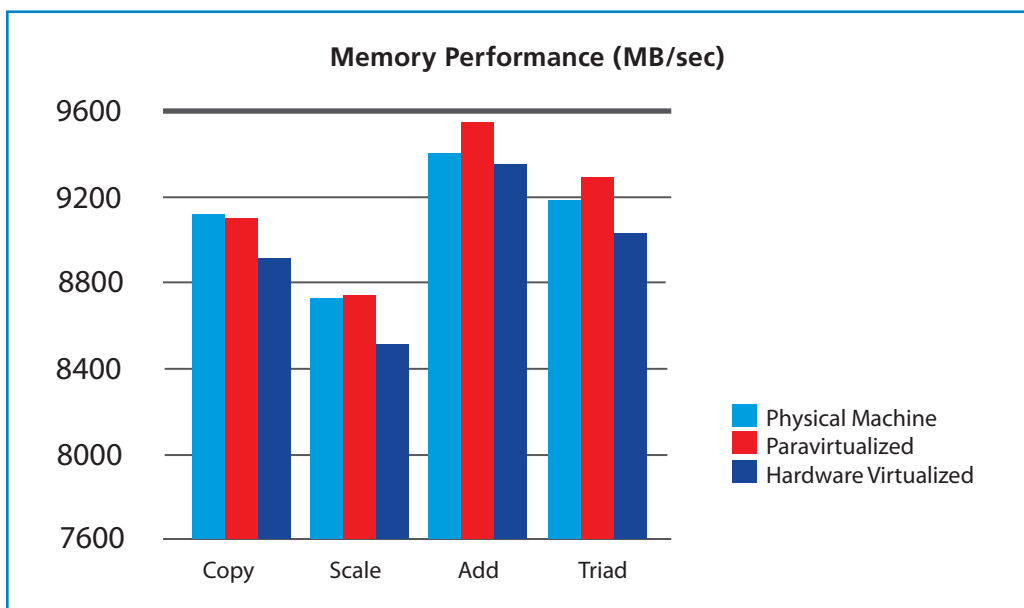
CPUs are increasing in speed much more quickly than computer memory systems, and as a result more applications will see performance degradation from memory bandwidth issues than computational performance.

The STREAM benchmark measures sustainable memory bandwidth and the corresponding computation rate for simple vector kernels. This benchmark is designed to work with datasets much larger than typical system cache, so results are indicative of the performance of very large, vector-style applications.

The results of the Univa memory test showed near-zero overhead of virtualization for both hardware and paravirtualized machines. In fact, in certain cases paravirtualized machines produced faster results than bare metal. The key takeaway with this benchmark is that memory-intensive applications will not degrade. Therefore, we should expect very good performance.

Benchmark: Network Performance

Univa tested network performance to understand the effect of virtualization on network I/O. This network performance benchmark test showed that the drivers and latest updates in





The machines powered by the Nehalem-based Core i7 series processors proved to be 120 percent faster than the Intel Core2 Quad Q6600 based machines for memory throughput.

Oracle VM 2.2.0 have entirely eliminated any slowdown in network performance when using paravirtualized machines.

Univa used the Iperf tests, which push as much data as possible between two machines in an attempt to saturate the network link. The test is run for a given number of seconds (in this case 30), and it reports the amount of data transferred, which is then normalized to megabytes/second.

This result showed that hardware virtualization suffered a significant penalty. Paravirtualization greatly improved performance of the VM instance to the same performance as bare metal.

Conclusion of Lab Tests

Conclusions from lab tests were very clear: Memory and CPU intensive applications perform extremely

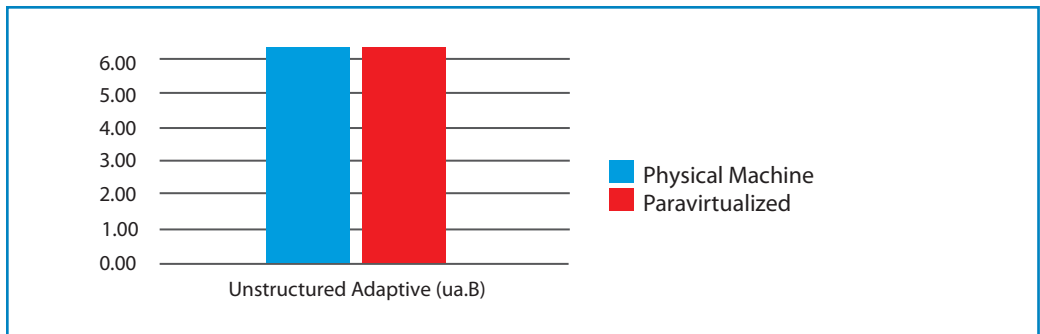
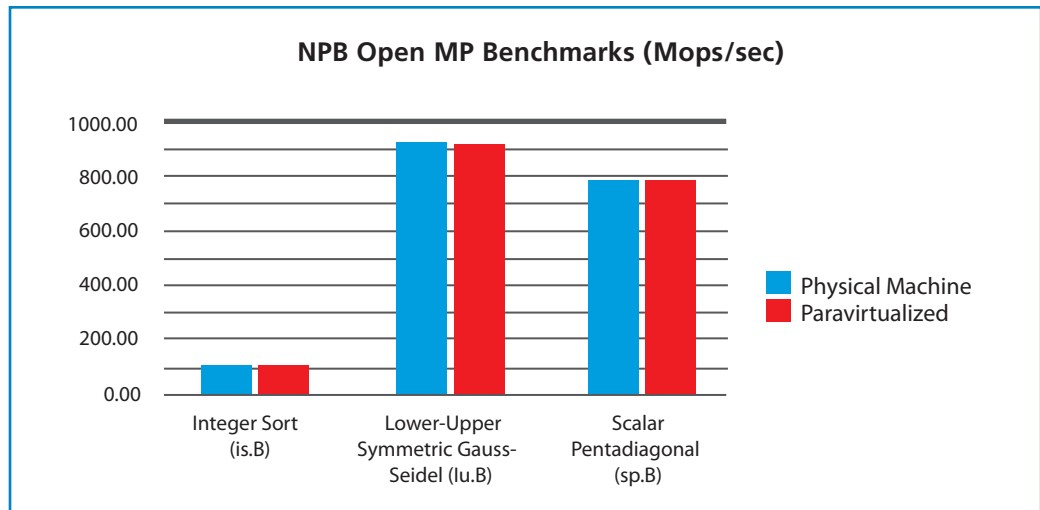
well in virtualized environments using Nehalem generation Intel® microarchitecture, even showing performance improvements over bare metal in some cases. VMs should take advantage of fast networks and read/write to NAS, like NetApp, to ensure maximum performance. Test results also demonstrated that Intel® core i7 series processors with Nehalem microarchitecture significantly outperformed previous generation quad-core processors.

APPLICATION BENCHMARKS

These benchmarks were run in a customer production environment and not in Univa labs. The applications were used for design, simulation and analysis in a private cloud within an electronic design automation (EDA) environment. The production systems used were Harpertown⁴ 8-core machines. All times are in seconds.

Application: Synopsys® HSIM

HSIM by Synopsys is a leading product for chip simulation and verification. HSIM jobs consume the entire CPU, and licenses are quite expensive, so





“With these results, we’ve proven that a computing environment running Oracle VM with UniCloud can do what was previously considered impossible: reduce or even reverse the performance penalty traditionally associated with virtualized environments. With Oracle VM and UniCloud, application users have a unique new option to take advantage of virtualization in their production environments.”

– Wim Coekaerts, Vice President of Linux and VM Engineering at Oracle

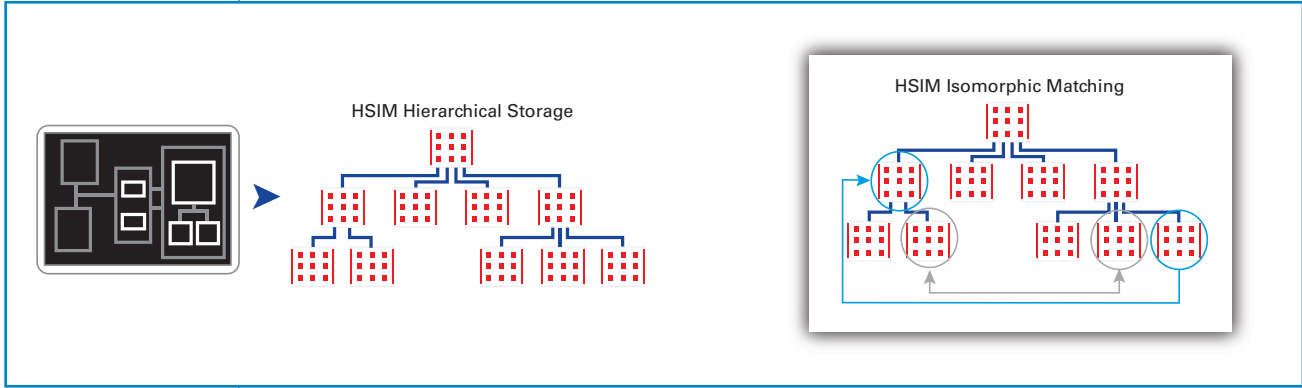
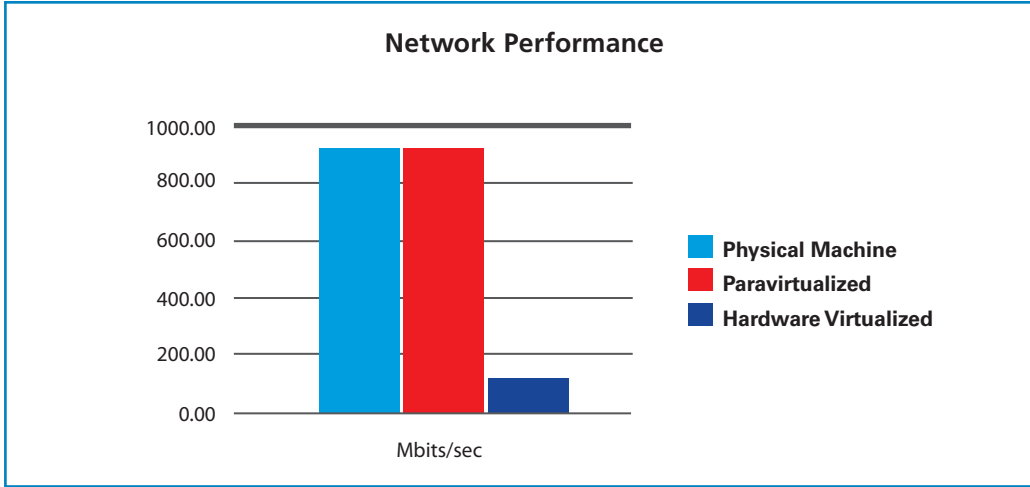
getting the most jobs done in the shortest amount of time is critical.

The HSIM benchmark involved comparing the results of running one, two, four, six and eight jobs on bare metal systems versus Oracle VM. Virtualized jobs⁵ were run in both “pinned” (affinity) and without affinity to compare the results of associating a VM virtual CPU core with a physical CPU core. In this test, we wanted to see the bare metal degradation and how closely VM performance followed the slope. As shown below, the single HSIM jobs ran 2.02 percent faster when run in a virtual machine with CPU affinity.

As the jobs scaled, both bare metal and virtualized jobs degraded equally from under 29 seconds to more than 34 seconds (@17%), as would be expected. Virtualized jobs’ performances degraded gracefully, essentially tracking the slowdown on bare metal machines.

The important result is the one showing that running eight HSIM virtualized jobs is a mere 1.04 percent slower than bare metal when CPU affinity was used. From this we concluded that VM affinity along with paravirtualization would produce very impressive results. The rest of the benchmarks therefore used these two settings.

It is therefore possible to checkerboard HSIM jobs across large-memory, reserved machines while they are “waiting” for high-priority jobs like Apache RedHawk. When such a job needs to be run, clearing the HSIM jobs off is a simple and practical operation taking mere seconds (depending on the memory of each VM). Utilizing reserved machines is now possible.



⁴Intel Xeon processor family that consists of dual die quad-core CPUs manufactured on a 45 nm process and featuring 1333 MHz to 1600 MHz front-side buses.
⁵A virtualized job means a virtual machine with one application running in it so eight virtualized jobs is eight virtual machines.



The important result is the result of running eight HSIM virtualized jobs a mere 1.04 percent slower than bare metal when CPU affinity was used.

Application	BareMetal	VM (CPU Affinity)	Slowdown	VM (No Affinity)	Slowdown
Hsim					
1 job	28.78	28.21	-2.02%	28.4	-1.34%
2 job	28.48	28.95	1.62%	28.32	0.56%
4 job	29.1	29.11	0.03%	31.03	6.22%
6 job	31.78	32.31	1.64%	32.19	1.27%
8 job	34.31	34.67	1.04%	34.99	1.94%

Application: Synopsys® PrimeTime

Synopsys PrimeTime is a timing sign-off solution and provides a benchmark with a longer window in time, running just over 96 minutes. The slowdown was 1.92 percent. However, this is easily offset by the fact that one could be recovering CPUs on previously reserved machines.

Application	Bare Metal	VM	VM Slowdown
Synopsys PrimeTime	5663	5774	1.92%

Application: Synopsys Design Compiler

Synopsys Design Compiler showed an impressive performance gain above 4 percent in a virtual machine. Clearly, this application is capable of exploiting virtualization.

Application	Bare Metal	VM	VM Slowdown
Synopsys Design Compiler	1172	1126	-4.09%

Application: Cadence UltraSim

Cadence UltraSim is a FastSPICE full chip simulator. The test results showed a 0.76 percent slowdown, or an additional 2 seconds.

Application	Bare Metal	VM	VM Slowdown
Cadence UltraSim	53263	53670	0.76%

Application: Magma

The Magma job in this test ran for nearly 15 hours and saw a 1.31 percent slowdown. With UniCloud, checkpointing this job is possible.

Application	Bare Metal	VM	VM Slowdown
Magma	151	153	1.31%

Application: Apache RedHawk™

Apache RedHawk is an EDA application that analyzes power, noise and reliability. RedHawk licenses are a significant expense per year per instance. Since this application is so expensive, every effort is made to get the license off the CPU as quickly as possible. An Apache RedHawk job is generally considered among the highest priority jobs, and many EDA shops will reserve machines to run only such work.

Our test results showed that the slowdown of RedHawk on Intel processors was less than 2 percent, particularly impressive since Apache RedHawk is a memory-intensive application.

SUMMARY OF BENCHMARK RESULTS

In summary, Univa analyzed results from five applications and nine benchmarks and has shown that UniCloud running on Nehalem generation Intel® microarchitecture and Oracle VM offsets the virtualization performance penalty due to 2.25x increase in performance over current-generation quad-core servers and nearly 9x performance gains over single-core servers. *The collected results show an average 2 percent slowdown, with several CPU and memory-intensive applications actually running between 2 percent and 4 percent faster in a VM.*

Highlights of the study results:

- For CPU-intensive applications, Oracle VM in paravirtualized mode utilizing Nehalem generation Intel® microarchitecture in general performed as well as bare metal.

- The NAS Parallel Benchmarks (NPB) test showed that virtualization overhead was non-existent and some of the results were faster than bare metal.
 - Intel® Nehalem microarchitecture proved to be 20 percent to 30 percent faster than the Intel Core2 Quad Q6600 based machines for this test.
- For the network performance benchmark, paravirtualization utilizing Intel® Nehalem microarchitecture based machines greatly improved performance of the VM instance, with equivalent performance as bare metal (zero slowdown).
- For the memory performance benchmark, performance improvements were consistent with memory intensive application results shown earlier.
 - These tests were run using Intel Core2 Quad Q6600 machines as well as the Intel® Nehalem core i7 series processor based machines.
 - Intel® core i7 series processors proved to be 80-120 percent faster than the Intel Core2 Quad Q6600 based machines for memory throughput.

CONCLUSION

The benefits of virtualization are many and offer a fundamental change in how technical computing infrastructures are built and managed. New management practices can be designed that increase utilization and improve optimization of licenses and resources. UniCloud, with its unique ability to dynamically provision software profiles across physical, virtual and public cloud hardware, introduces checkpointing that works, the ability to “get” the resource that matches workload requirements and the ability to rid the environment of poor performance due to swapping.

The fact remains that more than 80 percent of total datacenter costs are spent maintaining the legacy IT environment. Hence, server consolidation via technology refresh (fewer higher-performing servers) and virtualization drastically lowers IT operational expenses (OPEX), thus lowering the overall total cost of ownership (TCO).



UniCloud running on Nehalem generation Intel® microarchitecture and Oracle VM offsets the virtualization performance penalty due to 2.25x increase in performance over current generation quad-core and nearly 9x performance gains over single-core machines.

About the Author

Ashar Baig is an independent grid consultant with 15 years of high-tech industry experience focused on data center technologies in practice today and future trends. He has written textbooks, white papers, technology articles on cloud computing, grid computing, green computing, storage, virtualization, server consolidation, multi-core processors, multi-core optimization, high-speed server interconnects, CRM, business intelligence (BI), Web portals, and many other WAN and data center technologies. Baig has conducted seminars/webinars/podcasts and hosted numerous panel discussions and BOFs at various industry trade shows. Baig has held senior roles at some of North America's leading companies, such as Platform Computing, TELUS, Siemens and Intel. He frequently engages with customers at various levels, i.e., C-level, VP-level, director-level and end users. Having worked extensively throughout North America, Baig brings with him a seasoned business perspective, broad industry background, extensive customer contacts and solid data center understanding. He holds a Bachelor of Science from Rutgers University and an MBA from Iona College. ashar.baig@sympatico.ca