Principled Technologies®

Test Report
February 2006

64-bit financial application-based workload performance on Intel- and AMD-processor-based server platforms

Executive summary

Intel Corporation (Intel) commissioned Principled Technologies (PT) to measure the performance of two different 64-bit financial application-based workloads on two servers in various configurations. We compared the performance of the two servers, and we also gauged how performance scaled on the Intel Xeon processor-based server when upgrading from one to two processors and when running with and without HT Technology enabled.

The two financial workloads were the SunGard Adaptiv Credit Risk (SunGard ACR) and the Black-Scholes Kernel. Each workload is multithreaded and lets users specify the number of threads the program should run. Performance of both workloads can increase as each runs with more threads, up to an optimum thread count. For both workloads, the optimum number of threads is the number of logical and physical processors available on the server. (We refer to this as the optimum thread-to-processor configuration.) For both workloads on the Intel Xeon processor-based server, the optimum thread count is eight, because that server has two physical processors, each with two cores and two logical processors per core. By contrast, on the AMD Opteron processor-based server the optimum count is four (two processors, each with two cores). For details of the performance of each server with varying thread counts, see Figures 6 and 7. For more information on the two workloads, refer to the Workloads section of this report.

Key findings

- The Intel Xeon processor-based server delivered higher peak performance than the AMD Opteron processor-based server on both the SunGard Adaptiv Credit Risk workload setup and the Black-Scholes kernel workload (see Figure 1).
- The two-processor Intel Xeon processor-based server completed each of the workloads almost twice as fast as the same server with one Intel Xeon processor (see Figure 2).
- Hyper-Threading Technology on the Intel Xeon processor-based server significantly increased performance on both workloads (see Figure 3).

Figures 1 illustrates the relative peak (dual-processor) performance of each server. (One server contained two Intel Xeon dual-core 3.46-GHz processors with Hyper-Threading Technology (HT Technology); the other used two AMD Opteron 280 dual-core 2.4-GHz processors. Both servers had 4GB of RAM.) In this and the other performance charts, we normalized the results for each workload to the time the slower configuration took to complete that workload; that configuration's result in each chart is thus always 1.00. By normalizing, we make each data point in these charts a comparative number; higher results mean better performance (i.e., faster times to complete the workload with the specified number of threads).

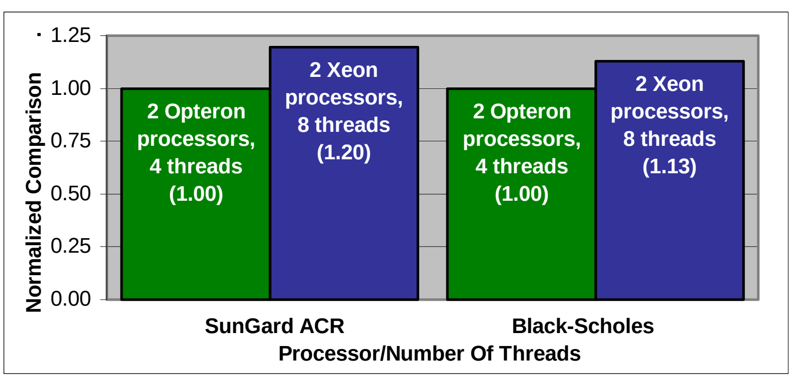

Figure 1: Peak (dual-processor) performance of the two servers with the optimum thread-to-processor configurations on both the SunGard ACR and Black-Scholes workloads.

As Figure 1 shows, the peak performance of the Intel Xeon processor-based server was about 20 percent higher than that of the AMD Opteron processor-based server on the SunGard Adaptiv Credit Risk workload—a speed difference that meant a user would receive a solution over one and a half minutes more quickly with the Xeon processor-based server. With the Black-Scholes workload, the peak performance of the Intel Xeon processor-based server was about 13 percent faster than that of the AMD Opteron processor-based server.

The Intel Xeon processor-based server demonstrated significant performance gains in both workloads both from the presence of the second processor and from its use of HT Technology. As Figure 2 shows, performance on each workload nearly doubled with the addition of a second Intel Xeon processor. Figure 3 demonstrates that the use of HT Technology by the Intel Xeon processor-based server also significantly improved performance in both financial model workloads.

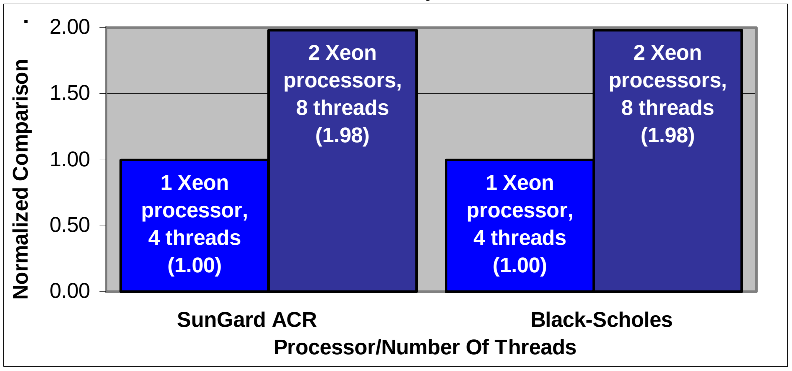

Figure 2: One- to two-processor performance scaling on the Intel Xeon processor-based server using the optimum threads-to-processor configurations on both the SunGard ACR and Black-Scholes workloads.

In addition to the tests whose results these first three figures present, we ran many other tests on each server. We tested both the single-physical-processor configurations and the dual-physical-processor configurations with 1, 2, 3, 4, 5, 6, 7, and, 8 threads for each workload; we present those results in the Test results section of this report.

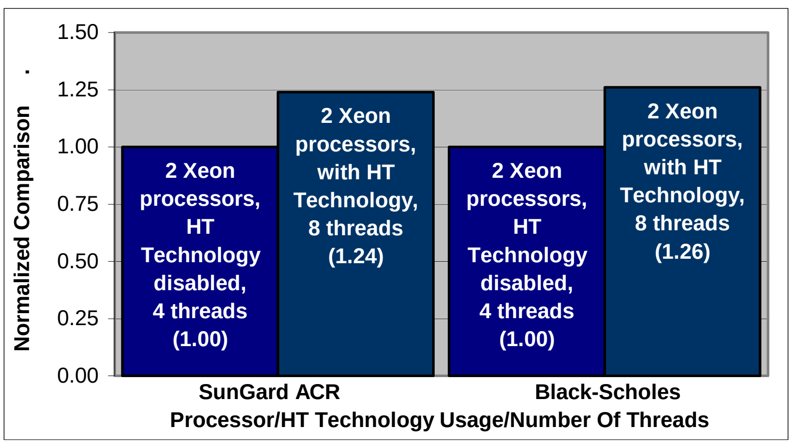

Figure 3: Performance improvements from the use of HT Technology on the dual-processor Intel Xeon processor-based server with the optimum threads-to-processor configurations on both the SunGard ACR and Black-Scholes workloads.

We also ran tests that demonstrated the performance benefit possible by building the Black-Scholes workload with Intel's C++ compiler; see the Performance gain from using Intel Compiler C++ for Intel section for more details.

Intel provided the servers and workloads. We executed all tests with clean installations of Microsoft Windows 2003 Server, x64 Enterprise Edition.

Workloads

SunGard Adaptiv Credit Risk

Per SunGard, "SunGard Adaptiv Credit Risk provides a total, real-time credit risk solution for counterparty credit exposure aggregation, global limit management, credit risk analytics and collateral management." This workload analyzes a large portfolio of client assets and generates a credit risk evaluation. The more quickly the workload completes, the more quickly the user receives the evaluation, so improving performance can improve productivity. SunGard developed the Adaptiv Credit Risk workload and supplied the computational engine and financial data.

Per SunGard, “With annual revenue of $4 billion, SunGard is a global leader in software and processing solutions for financial services, higher education and the public sector. SunGard also helps information-dependent enterprises of all types to ensure the continuity of their business. SunGard serves more than 25,000 customers in more than 50 countries, including the world's 50 largest financial services companies. SunGard Adaptiv Credit Risk is a risk management system that supports the credit risk management on all levels by combining comprehensive credit risk related functionality, powerful real-time analytic capabilities and sophisticated user interfaces and reporting. SunGard Adaptiv Credit Risk (www.sungard.com/adaptiv) provides global scalability, real-time performance and the capacity to handle vast trading volumes.” SunGard Adaptiv Credit Risk has an open architecture and uses middleware, XML-based formats, industry standard technologies, and data standards.

Black-Scholes kernel workload

The Black-Scholes kernel workload is based on a financial modeling algorithm for the pricing of European-style options. After its publication in 1973 by Fisher Black, Myron Scholes, and Robert Merton, its impact was enormous and rapid. The benchmark consists of a kernel that implements a derivative of the Black and Scholes technique. SunGard developed the code, which uses a continuous-fraction technique that is more accurate than the more traditional polynomial approximation technique. Intel provided an enhanced 32-bit version of the Black-Scholes Kernel to www.2cpu.com, which created a 64-bit version. Intel provided the www.2cpu.com 64-bit version source for the executables we used in this report. We reviewed that source and found no changes designed to favor one processor architecture over another.

We used Microsoft Visual Studio 2005 to compile the Black-Scholes kernel workload source code. To optimize the code for the Intel Xeon-based server, we used the compiler’s “/favor:EM64T” option. To optimize the code for the AMD Opteron processor-based server, we selected the compiler’s “/favor:AMD64” option. We present the details of how we compiled the source code in the Test methodology section of this report.

Performance gain from using Intel Compiler C++ for Intel

To see how much additional benefit users might realize from using the Intel C++ compiler, we created a Black-Scholes kernel workload executable for the Intel Xeon processor-based server with that compiler and compared its results with those of the executable we built with the Microsoft compiler. As Figure 4 shows, the Intel compiler boosted the server’s performance by approximately eight percent—a significant gain.

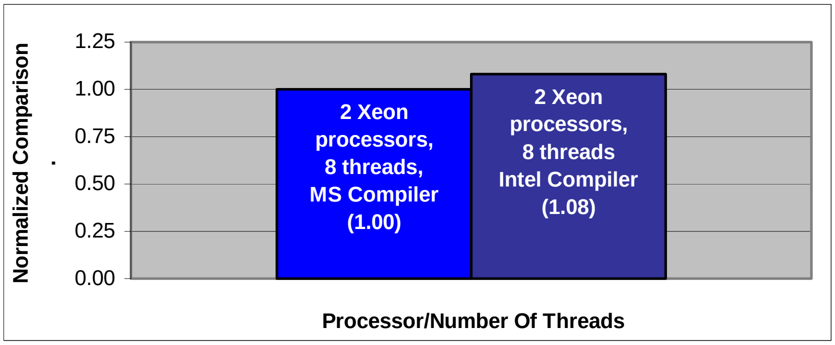

Figure 4: Peak (dual-processor) of the Intel Xeon processor-based server using the optimum threads-to-processor configurations with both Microsoft and Intel compiler versions of the Black-Scholes workload.

Test results

Figure 5 details the results of our tests with up to eight threads using the SunGard Adaptiv Credit Risk workload. For each test, we present the median run of the three individual test runs we executed. The test produces the time, in seconds, the server took to complete the workload; lower (faster) completion times are better.

Server system\ # of threads	1	2	3	4	5	6	7	8
AMD Opteron processor-based server- 1 processor	2,397.2	1,206.3	1,235.5	1,221.9	1,204.1	1,264.8	1,206.813	1,195.1
AMD Opteron processor-based server - 2 processors	2,423.2	1,220.2	828.6	605.5	621.6	638.8	653.531	602.5
Intel Xeon processor-based server - 1 processor	2,424.9	1,568.2	1,127.4	1,000.9	1,020.3	1,015.3	1,017.594	1,024.2
Intel Xeon processor-based server - 2 processors	2,421.6	1,341.8	962.7	748.4	639.2	581.8	549.500	506.3
Intel Xeon processor-based server - 1 processor (HT Technology disabled)	2,425.9	1,251.1	1,237.2	1,230.7	1,232.9	1,254.0	1,253.688	1,249.8
Intel Xeon processor-based server - 2 processors (HT Technology disabled)	2,421.9	1,215.0	836.1	628.6	637.1	644.9	653.1	631.1

Figure 5: Median completion times (in seconds) of the server configurations with varying thread counts using the SunGard ACR workload. Lower times are better.

Figure 6 details the results of our tests with up to eight threads using the Black-Scholes kernel workload that we created by compiling with Microsoft Visual Studio 2005 and optimizing for each server platform. For each test, we present the median run of the three individual test runs we executed. The test produces the time, in seconds, the server took to complete the workload; lower (faster) completion times are better.

Server System\ # of threads	1	2	3	4	5	6	7	8
AMD Opteron processor-based server- 1 processor	15.1	7.6	7.8	7.6	7.7	7.6	7.7	7.7
AMD Opteron processor-based server - 2 processors	14.6	7.3	5.0	3.8	4.4	3.9	4.2	4.0
Intel Xeon processor-based server - 1 processor	16.9	10.1	7.6	6.7	7.3	6.7	6.8	6.8
Intel Xeon processor-based server - 2 processors	16.9	8.5	6.0	4.4	5.3	4.4	3.8	3.4
Intel Xeon processor-based server - 1 processor (HT Technology disabled)	16.9	8.5	8.5	8.5	8.5	8.5	8.6	8.5
Intel Xeon processor-based server - 2 processors (HT Technology disabled)	16.9	8.5	5.7	4.3	5.1	4.3	4.7	4.3

Figure 6: Median completion times (in seconds) of the server configurations with varying thread counts using the Black-Scholes kernel workload that we compiled with Microsoft Visual Studio and optimized for each platform. Lower times are better.

We also built a version of the workload optimized for the Intel Xeon processor-based server using the Intel C++ Compiler for Intel 9.0 in concert with Microsoft Visual Studio 2005, which the Intel compiler requires. Figure 7 details the results of our tests with up to eight threads using this version of the Black-Scholes kernel workload on the Intel Xeon processor-based server and the optimized-for-AMD version of the workload we built with Microsoft Visual Studio 2005 on the AMD Opteron processor-based server. As you can see, using the Intel compiler improved the performance of the workload on the Intel Xeon processor-based server.

Server System\ # of threads	1	2	3	4	5	6	7	8
AMD Opteron processor-based server- 1 processor	15.1	7.6	7.8	7.6	7.7	7.6	7.7	7.7
AMD Opteron processor-based server - 2 processors	14.6	7.3	5.0	3.8	4.4	3.9	4.2	4.0
Intel Xeon processor-based server - 1 processor	17.5	10.1	7.4	6.1	7.0	6.2	6.3	6.2
Intel Xeon processor-based server - 2 processors	17.5	8.8	6.7	5.0	4.9	4.1	3.5	3.1
Intel Xeon processor-based server - 1 processor (HT Technology disabled)	17.5	8.8	8.9	8.8	8.9	8.8	8.9	8.8
Intel Xeon processor-based server - 2 processors (HT Technology disabled)	17.5	8.8	5.8	4.4	5.4	4.4	4.9	4.7

Figure 7: Median completion times (in seconds) of the server configurations with varying thread counts using the Black-Scholes kernel workload with the Intel compiler for the Intel Xeon processor-based server and the Microsoft compiler for the AMD Opteron processor-based server. Lower times are better.

Test methodology

Figure 8 summarizes a few key aspects of the configurations of the two server systems; Appendix A provides detailed configuration information.

Server system	Dual-Core Intel Xeon processor based Software Development Vehicle (SDV)	Dual-Core AMD Opteron processor-based server
Processor frequency (GHz)	3.46	2.4
Motherboard	Intel Bridgeport SDV	Uniwide Technologies, Inc. SS232-128-02
Chipset	Intel Dual-Processor Server chipset codename Blackford	NVIDIA nForce4 Professional 2050/2200
RAM (4096 MB in each)	4 x 1024MB PC2-4200 DDR2-SDRAM FBDIMM	4 x 1024MB PC-3200 DDR-SDRAM
Hard drive	Western Digital Raptor WD740GD (74GB)	Western Digital Caviar RE WD1600SD (160GB)

Figure 8: Summary of key aspects of the server configurations.

Intel configured and provided both servers.

The difference in RAM types reflects the capabilities of the two motherboards: The Intel motherboard offered a front-side bus speed of 1067 MHz and contained Fully-Buffered DIMM (FBDIMM) modules that used commodity DDR2 PC2-4200 533MHz memory components. The Uniwide motherboard supported 184-pin DDR memory, and the highest memory speed available for the AMD Opteron processor-based server was DDR PC3200 400MHz RAM.

Another hardware difference between the two servers was the hard drive speed. The Western Digital Raptor WD740GD hard drive in the Intel Xeon processor-based server had a rotational speed of 10,000 RPM. The Western Digital Caviar RE WD1600SD in the AMD Opteron processor-based server had a rotational speed of 7,200 RPM. We do not believe the performance advantage of the Intel Xeon processor-based server in this test is due to this difference, because neither workload depends heavily on disk speed; rather, they rely most on processor/RAM speed.

We began by installing a fresh copy of Microsoft Windows 2003 Server, x64 Enterprise Edition on each server. We followed this process for each installation:

1. Assigned a computer name that reflected the processor name and vendor.
2. For the licensing mode, we used the default setting of five concurrent connections.
3. Did not enter a password for the administrator log on.
4. Selected Eastern Time Zone.
5. Used typical settings for the Network installation.
6. Used “WORKGROUP” for the workgroup.

The Microsoft Windows Update site suggested the following updates for both servers, which we applied:

- Cumulative Security Update for Internet Explorer for Windows Server 2003 x64 Edition (KB905915)
- Microsoft Base Smart Card Cryptographic Service Provider Package: x64 (KB909520)
- Security Update for Windows Server 2003 x64 Edition (KB896424)
- Security Update for Windows Server 2003 x64 Edition (KB900725)
- Security Update for Windows Server 2003 x64 Edition (KB902400)
- Security Update for Windows Server 2003 x64 Edition (KB904706)
- Security Update for Windows Server 2003 x64 Edition (KB901017)
- Security Update for Windows Server 2003 x64 Edition (KB890046)
- Security Update for Windows Server 2003 x64 Edition (KB899587)
- Security Update for Windows Server 2003 x64 Edition (KB899591)
- Security Update for Windows Server 2003 x64 Edition (KB893756)
- Security Update for Windows Server 2003 x64 Edition (KB899588)
- Security Update for Windows Server 2003 x64 Edition (KB901214)
- Security Update for Windows Server 2003 x64 Edition (KB896422)
- Security Update for Windows Server 2003 x64 Edition (KB896358)

- Security Update for Windows Server 2003 x64 Edition (KB896428)
- Update for Windows Server 2003 x64 Edition (KB910437)
- Update for Windows Server 2003 x64 Edition (KB898715)

We then installed the Microsoft .NET Framework, version 2.0.50727, which SunGard recommends in the documentation that came with the SunGard Adaptiv Credit Risk workload. SunGard developed the SunGard Adaptiv Credit Risk application in Microsoft C#. The application executes as a process within the host Microsoft .NET framework and requires a specific version of .NET, so we downloaded and installed that version: Microsoft .NET Framework x64 Version 2.0.50727, available at http://msdn.microsoft.com/netframework/.

We rebooted the server before each test run.

To enable or disable HT Technology on the Intel Xeon processor-based server, we used the BIOS' HT setting, which is in the Advanced->Blackford Configuration->CPU /FSB Configuration section of the BIOS.

Testing with one processor

When we ran the single-processor tests on each server, we physically removed the second processor. Because the AMD Opteron processor-based server assigns each CPU its own RAM, we also removed the RAM associated with that second processor, which left the server with 2GB of RAM. Though the Intel Xeon processor-based server does not associate RAM with specific processors, to ensure fair and consistent results, we also reduced the RAM in that system to 2GB for the single-processor tests.

Installation of the SunGard Adaptiv Credit Risk 64-bit version workload

Intel supplied the SunGard Adaptiv Credit Risk 64-bit application and workload compressed in a zip file on CD-ROM. We unzipped the file's contents into the folder C:\Sungard on each system. The files in that folder contained both the SunGard Adaptiv Credit Risk executable (RiskAnalytics.exe) and the two data files the workload uses:

- *MarketData.dat* – sample data representing a fictional set of financial market conditions
- *Portfolio D.cpf* – sample data representing a fictional customer's investment portfolio

SunGard Adaptiv Credit Risk workload switches/parameters

This workload provides the following switches, which we set as appropriate for each test run:

- */numThreads* or */t*
  Designates the number of threads the workload should run. We set this to the number of threads we wanted in each test.
- */outputFileName or /o*
  Saves the results in a text file and overwrites that file if the file already exists. We saved each test's results in a separate file.

By default, the application detects the number of logical processors and runs with one thread per logical processor. So, by default the application would run as follows:

- AMD Opteron processor-based server with 1 processor: 2 threads
- AMD Opteron processor-based server with 2 processors: 4 threads
- Intel Xeon processor-based server with 1 processor and HT Technology disabled: 2 threads
- Intel Xeon processor-based server with 1 processor and HT Technology enabled: 4 threads
- Intel Xeon processor-based server with 2 processors and HT Technology disabled: 4 threads
- Intel Xeon processor-based server with 2 processors and HT Technology enabled: 8 threads

The typical state of the Intel-based server is to run with HT Technology enabled. Consequently, the Intel Xeon processor-based server would by default run the application with more threads in both the one- and two-processor configurations than the AMD Opteron processor-based server.

Running the SunGard Adaptiv Credit Risk workload

We rebooted the server before each individual test and then followed this process to run the test:

1. Opened a DOS command window.
2. Navigated to the C:\Sungard folder.
3. Entered the following command:
   "RiskAnalytics /o <server name>_<# of CPUs>_<# of threads>_<run no.>.txt /t <# of threads>", where
   - <server name> was either Intel or AMD, as appropriate
   - <# of CPUs> was either 1 or 2, as appropriate
   - <# of threads> was either 1, 2, 3, 4, 5, 6, 7, or 8 as appropriate
   - <run no.> was either 1, 2, or 3 (we ran each test three times)
4. The workload would then start and open a monitoring console like the one in Figure 7, but without the results graph (see next point for more on that graph).
5. We clicked on Calculate at the top left corner of the window.
6. A "Percentage Complete" progress message displayed in the bottom left corner of the status bar.
7. When the workload completed, the monitoring console presented a graph of the results over the course of the test; Figure 9 shows an example graph. The text below the graph in the display describes the parameters the workload used for this run and the time (in seconds) it took to complete the test. We recorded this time as the primary result of each test.

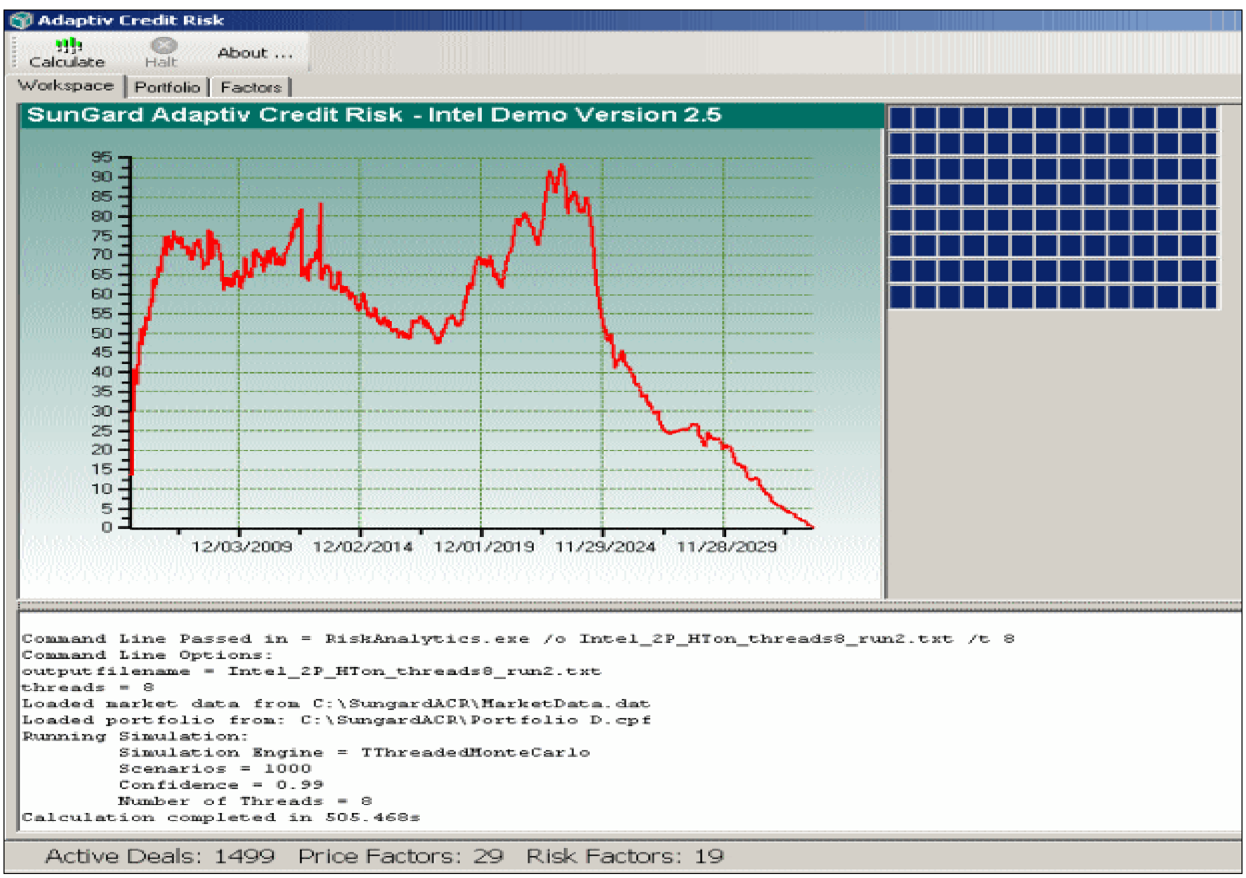

Figure 9: An example of the monitoring console after the SunGard ACR workload completes.

Installation of the Black-Scholes 64-bit version kernel workload

Intel supplied the Black-Scholes 64-bit kernel workload compressed in a zip file. We unzipped the file's contents into a directory on a system separate from the servers under test. The folder contained C++ source code files and make files.

We built versions of this workload with both the Microsoft and Intel compilers.

We used the Visual Studio project Intel provided to build the 64-bit versions of the workload with Microsoft Visual Studio 2005 as follows:

1) Double click the black_scholes_x64.vcproj file. Visual Studio automatically opens.
2) In the Solution Explorer pane, right-click black_scholes_x64, and select Properties
3) From inside the "black_scholes_x64 Property Pages" dialog, click the "Configuration Manager..." button.
4) From the "Active solution configuration:" drop-down menu, choose "Optimized_x64".
5) From the "Active solution platform:" drop-down menu, choose "x64".
6) Close the Configuration Manager.
7) While still inside the "black_scholes_x64 Property Pages" dialog, expand the C/C++ properties, and click "Command Line".
8) In the "Additional options:" text box, type either "/favor:EM64T" or "/favor:AMD64" to build the executable for the Intel Xeon processor-based server or the AMD Opteron processor-based server, respectively.
9) Click "OK" to close the "black_scholes_x64 Property Pages" dialog.
10) From the "Build" menu, select "Rebuild Solution".

We used the Intel C++ Compiler for Intel 9.0 and Microsoft Visual Studio 2005 to build 64-bit versions of the "Optimized_x64" executables. Intel provided both applications. As part of its compilation process, the Intel C++ Compiler invokes the compiler from the Microsoft Windows Platform SDK Collection for Windows Server SP1, AMD64 version.

As part of the process of building the executables, we naturally had to specify options for each of these compilers. For the Intel compiler, we used the compiler options in the 32-bit make files Intel provided. For the Microsoft compiler, we used the options in the project for the Optimized_x64 executable we received. (Per Intel, the staff at www.2cpu.com started with the 32-bit version of the Black-Scholes kernel workload and created this 64-bit version). In some cases, the Intel compiler overrode or ignored the Microsoft options; when that occurred, we ultimately omitted those switches.

Once we had built the executables, we created a folder on the servers under test called BlackScholes and stored the executables in that folder.

Black-Scholes kernel workload switches/parameters

This workload provides the following switches, which we set as appropriate for each test run:

- */numThreads* or */t*
  Designates the number of threads the workload should run. We set this to the number of threads we wanted in each test.
- *Number of steps*
  Designates the number of steps the workload should use to calculate the option price.

By default, the workload assumes the following values:

- Number of threads: 4
- Number of steps: 100,000,000

Unlike the SunGard Adaptiv Credit Risk application, this workload defaults to four threads regardless of the number of logical processors available on the server.

Running the Black-Scholes kernel workload

We rebooted the server before each individual test and then followed this process to run the test:

1. Opened a DOS command window.
2. Navigated to the C:\BlackScholes folder.
3. Entered the following command:
   “blackscholes_x64.exe ,<# of threads> > <server name>_<# of CPUs>_<# of threads>_<run no.>.txt, where
   a. <server name> was either Intel or AMD, as appropriate
   b. <# of CPUs> was either 1 or 2, as appropriate
   c. <# of threads> was either 1, 2, 3, 4, 5, 6, 7, or 8 as appropriate
   d. <run no.> was either 1, 2, or 3 (we ran each test three times)

Each execution of the workload generates a text file that includes how long the workload took to complete. We recorded that time as the result for each run.

Appendix A: Test server configuration information

This appendix provides detailed configuration information about each of the two test server systems.

Processors	Dual-Core Intel Xeon processor based Software Development Vehicle (SDV)	AMD Opteron 280 2.4 GHz Dual-Core processor
System configuration information		
General		
Processor and OS kernel: (physical, core, logical) / (UP, MP)	2P4C8L / MP	2P4C4L / MP
Number of physical processors	2	2
Single/Dual-core processors	Dual-core	Dual-core
System Power Management Policy	AC/Always On	AC/Always On
CPU		
System type	Server	Server
Vendor	Intel	AMD
Name	Intel Xeon	AMD Opteron
Stepping	2	6
Socket type	LGA-771	940
Core frequency (GHz)	3.46	2.4
Front-side bus frequency (MHz)	1067	1000
L1 Cache	16 KB + 12 KB	64 KB + 64 KB
L2 Cache	2048 KB per core	1024 KB per core
Platform		
Vendor and model number	Intel Dual-Processor server platform codename Bensley	Uniwide UniServer 1322 1U Rack Server System
Motherboard model number	Intel Bridgeport (SDV)	Uniwide Technologies, Inc. SS232-128-02
Motherboard chipset	Intel Dual-Processor server chipset codename Blackford	NVIDIA nForce4 Professional 2050/2200
Motherboard revision number	C97294-204	0
Motherboard serial number	IWBP54103848	WTOPET0000143
BIOS name and version	Tiano-based Intel-developed BIOS version 63-0100-00001-00101111-120505-Chipset, 12/05/2005	American Megatrends BIOS version 64-0100-000001-00101111-111505-CK8-04, 11/15/2005
BIOS settings	Increased the Set Processor Multiplier from 12 to 13 so the processor would run at 3.46 GHz	Default
Chipset INF driver	Microsoft version 5.2.3790.1830, 10/01/2002	NVIDIA version 5.1.2600.445, 7/27/2004
Memory module(s)		
Vendor and model number	Micron MT18HTF12872FD	Viking Components VI4CR287228ETPA2
Type	FBDIMM memory modules that use commodity 240-pin DDR2-SDRAM PC2-4200 ECC Registered memory components	184-pin DDR400-SDRAM PC3200 ECC Registered memory components
Speed (MHz)	533	400
Speed in the system currently running @ (MHz)	266	200

Timing/Latency (tCL-tRCD-tRP-tRASmin)	4.0-4-4-12	3.0-3-3-8
Size	4096 MB	4096 MB
Number of RAM modules	4 x 1 GB	4 x 1 GB
Chip organization	Double-sided	Double-sided
Channel	Single	Single
Hard disk		
Vendor and model number	Western Digital Raptor WD740GD	Western Digital Caviar RE WD1600SD
Number of disks in system	1	1
Size	74 GB	160 GB
Buffer Size	8 MB	8 MB
RPM	10000	7200
Type	SATA 1.5	SATA 1.5
Controller	Microsoft Primary IDE Channel (due to use of standard Windows drivers)	nForce4 Professional 2200 SATA II
Driver	Microsoft version 5.2.3790.1830, 10/01/2002	Microsoft 5.2.3790.1830, 10/01/2002
Operating system		
Name	Microsoft Windows 2003 Server, x64 Enterprise Edition	Microsoft Windows 2003 Server, x64 Enterprise Edition
Build number	Build 3790	Build 3790
Service pack	N/A	N/A
Microsoft Windows update date	12/12/2005	12/12/2005
File system	NTFS	NTFS
Kernel	ACPI Multiprocessor x64-based PC	ACPI Multiprocessor x64-based PC
Language	English	English
Microsoft DirectX version	DirectX 9.0c	DirectX 9.0c
Graphics		
Vendor and model number	ATI Rage XL PCI	ATI Rage XL Family
Chipset	B41	B41
BIOS version	ATI Video BIOS	GR-xlacrs3p.003-4.328
Type	Integrated	Integrated
Memory size	8 MB Shared DDR	8 MB Shared DDR
Resolution	1024 x 768 x 32-bit color	1024 x 768 x 32-bit color
Driver	ATI Technologies version 6.14.10.6025, 12/03/2004	ATI Technologies version 6.14.10.6025, 12/03/2004
Network card/subsystem		
Vendor and model number	2 x Intel PRO/1000 EB Dual-port Gigabit Ethernet Adapters	2 x Broadcom NetXtreme Gigabit Ethernet Adapters
Type	Integrated	Integrated
Driver	Intel version 8.0.21.0	Broadcom version 8.39.1.0, 07/21/2005
Other Network Card Information	N/A	N/A
Optical drive		
Vendor and model number	TEAC DW-552G DVD-ROM (DVD Read 16x, CD-ROM Read 52x)	N/A
Type	DVD-ROM	N/A
Interface	Internal	N/A
USB ports		
# of ports	8 (2 front, 6 back)	4 (2 front, 2 back)
Type of ports (USB1.1, USB2.0)	2.0	2.0

Figure 10: Detailed system configuration information for both servers.

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