TEST REPORT
MAY 2006

64-bit SunGard ACR financial workload performance and power consumption on Intel- and AMD-processor-based servers

Executive summary

Intel Corporation (Intel) commissioned Principled Technologies (PT) to measure the performance of the 64-bit SunGard Adaptiv Credit Risk (SunGard ACR) financial application-based workload on dual-processor servers using the following three processors:

- 64-bit Intel Xeon Processor 3.60 GHz
- Dual-Core Intel Xeon Processor 5160
- Dual-Core AMD Opteron 285

The SunGard ACR workload is multithreaded and allows users to specify the number of threads the program should run. Performance of the workload can increase as it runs with more threads, up to an optimum thread count, generally equal to the number of logical and physical processors available on the server. (We refer to this as the optimum thread-to-processor configuration.)

KEY FINDINGS

- The Dual-Core Intel Xeon Processor 5160-based server delivered 43 percent more performance/watt than the Dual-Core AMD Opteron 285-based server (see Figure 1). (We calculated performance/watt using system-level power measurements.)
- The Dual-Core Intel Xeon Processor 5160-based server delivered almost 25 percent higher peak performance than the Dual-Core AMD Opteron 285-based server (see Figure 2).
- The Dual-Core Intel Xeon Processor 5160-based server had almost 13 percent lower average power usage while running the workload than the Dual-Core AMD Opteron 285-based server (see Figure 4).

The optimum thread count for our testing was four on the Dual-Core Intel Xeon Processor 5160-based server and the Dual-Core AMD Opteron 285-based server. The reason is that each of these servers has two physical processors with two cores per processor, or four available execution units.

The 64-bit Intel Xeon Processor 3.60 GHz-based server has two physical single-core processors, each of which supports Hyper-Threading Technology (HT Technology). Consequently, it, too, has four execution units available, though these are logical execution units. Thus, we expected the optimum thread count for this server would also be four. In our testing, however, the optimum thread count proved to be eight, though the improvement over four threads was small. We do not know the reason that eight threads proved to be optimal.

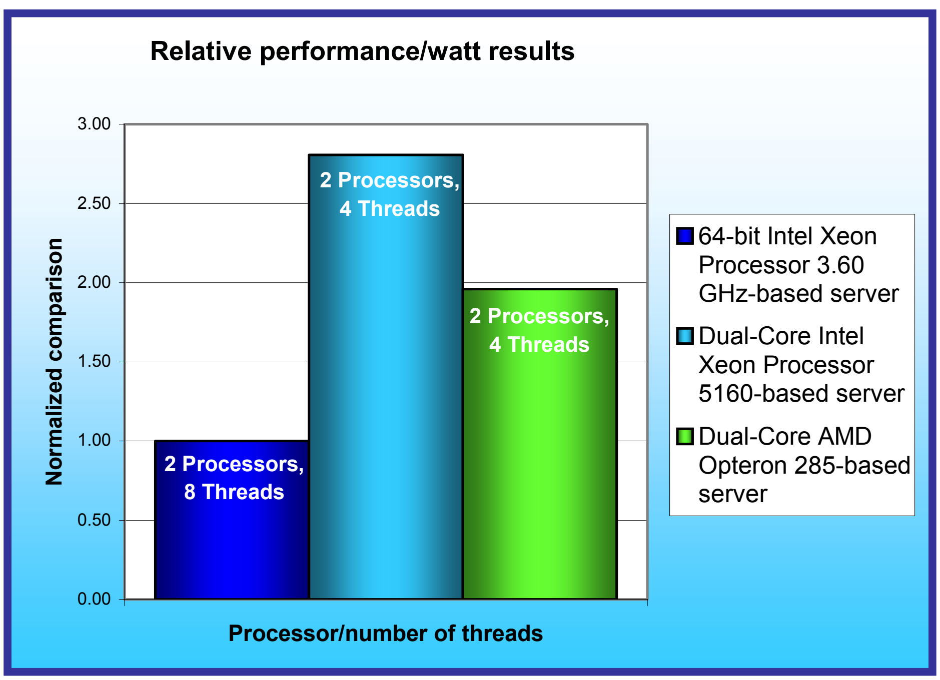

Figure 1: Performance/watt (dual-processor) results of the test servers running the SunGard ACR workload. Higher numbers indicate better performance/watt.

In this section, we discuss the best results for each server. For complete details of the performance of each server with varying thread counts, see the "Test results" section.

Figure 1 illustrates the performance/watt for each of the three servers. In this and the other performance charts in this section, we normalized the results for each workload to the time the slowest configuration took to complete that workload. The slowest system's result is thus always 1.00. By normalizing, we make each data point in these charts a comparative number, with higher results indicating better performance (i.e., faster times to complete the workload with the specified number of threads).

To calculate the performance/watt we used the following formula:

Performance/watt = (3600 / (the benchmark's duration in seconds)) / (average power consumption in watts during the time period in which the benchmark was delivering peak performance)

This formula converts the elapsed time the benchmark took to complete into a runs (or jobs) per hour metric, which we then use to compute the performance/watt.

As Figure 1 illustrates, the Dual-Core Intel Xeon Processor 5160-based server delivered 43 percent more performance/watt than the Dual-Core AMD Opteron 285-based server and 180.6 percent more performance/watt than the 64-bit Intel Xeon Processor 3.60 GHz-based server.

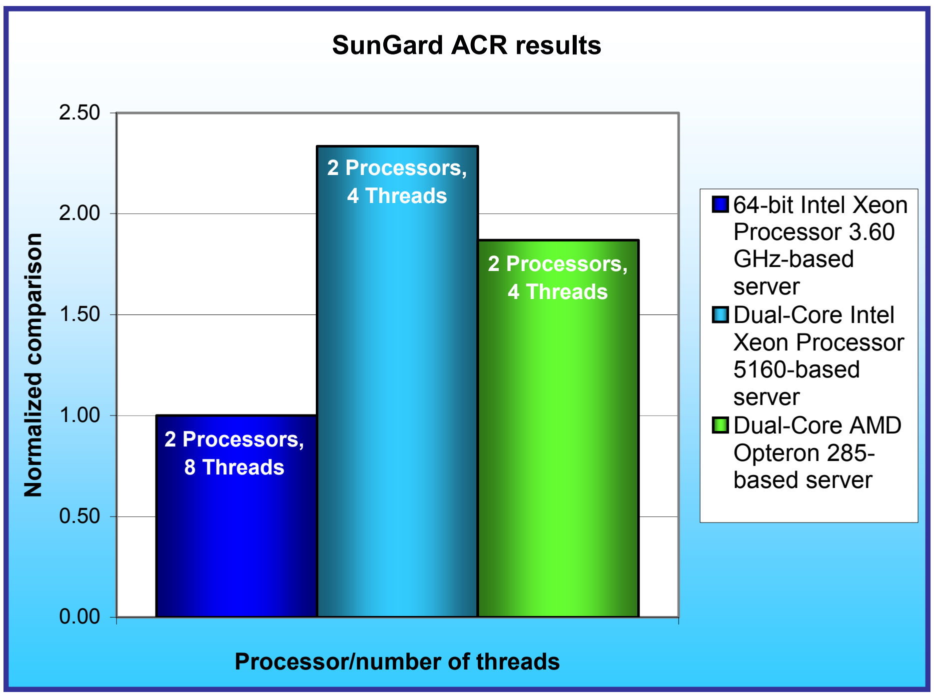

Figure 2: Normalized peak (dual-processor) performance of the servers with optimum thread-to-processor configurations on the SunGard ACR workload. Higher numbers are better.

Figure 2 portrays the relative peak (dual-processor) performance of each server. The Dual-Core Intel Xeon Processor 5160-based server finished the SunGard ACR workload in 443.4 seconds, almost 25 percent faster than the Dual-Core AMD Opteron 285-based server, which finished the same workload in 553.9 seconds. This speed difference means a user would receive a solution one minute and 50 seconds faster with the Dual-Core Intel Xeon Processor 5160 -based server. The Dual-Core Intel Xeon Processor 5160-based server was 133.5 percent faster than the 64-bit Intel Xeon Processor 3.60 GHz-based server, which took 1,035.2 seconds to complete the same workload.

Figure 3 shows a plot of the power usage of the three servers as they were running the benchmark. The red lines indicate the power measurement interval, the time during which the server was delivering peak performance and during which we captured power measurements. Lower power consumption is better. The Dual-Core Intel Xeon Processor 5160-based server both started with a lower power consumption while idle and achieved its peak performance while drawing less power—almost 13 percent less—than the Dual-Core AMD Opteron 285-based server. (The drop in power consumption back to idle state for both the Dual-Core Intel Xeon Processor 5160-based server and the Dual-Core AMD Opteron 285-based server occurred when each of those servers finished the workload.)

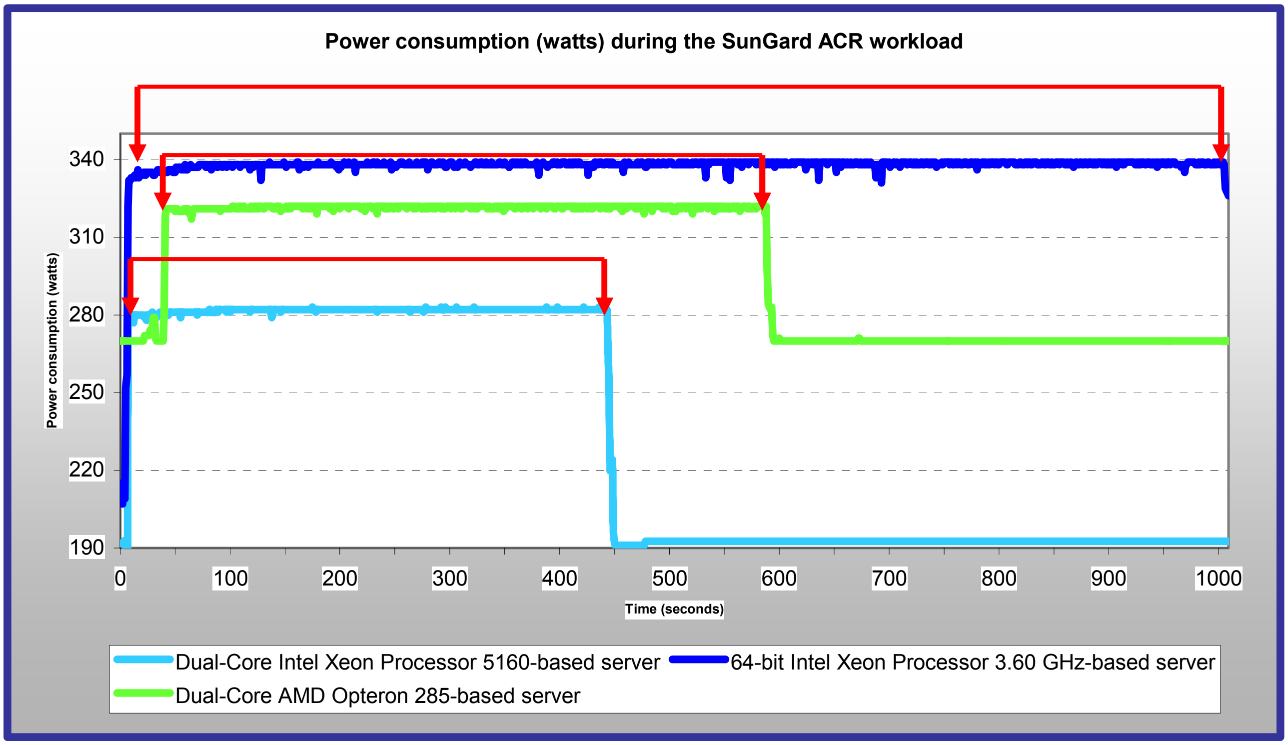

Figure 3: Power consumption (in watts) of each of the servers throughout the course of executing the SPECjbb2005 benchmark. Lower power consumption is better.

Workload

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, and industry-standard data and technologies.

Test results

Figure 4 details the results of our tests with two, four, and eight threads using the SunGard ACR 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 completion times are better.

Server / # of threads	2	4	8
64-bit Intel Xeon Processor 3.60 GHz-based server – 2 processors	1,209.8	1,096.0	1,035.2
Dual-Core Intel Xeon Processor 5160-based server – 2 processors	886.0	443.3	456.5
Dual-Core AMD Opteron 285-based server – 2 processors	1,142.6	553.9	566.5

Figure 4: Median completion times (in seconds) of the servers with varying thread counts using the SunGard ACR workload. Lower times are better.

As Figure 4 shows, both the Dual-Core Intel Xeon Processor 5160-based server and the Dual-Core AMD Opteron 285-based server achieved their fastest completion times with four threads, which means four threads is the optimum thread-to-processor configuration for these servers. In contrast, the 64-bit Intel Xeon Processor 3.60 GHz-based server achieved its fastest completion time with eight threads, making eight threads the optimum thread-to-processor configuration for that server.

Server / # of threads	2	4	8
64-bit Intel Xeon Processor 3.60 GHz-based server – 2 processors	315.2	338.2	336.6
Dual-Core Intel Xeon Processor 5160-based server – 2 processors	245.0	280.1	279.9
Dual-Core AMD Opteron 285-based server – 2 processors	295.8	321.0	319.8

Figure 5: Average power usage (in watts) of the servers with varying thread counts running the SunGard ACR workload. Lower times are better.

Figure 5 details the average power consumption of the test servers during the median runs of our tests with two, four, and eight threads. The Dual-Core Intel Xeon Processor 5160-based server had almost 13 percent lower average power usage during its fastest run of the workload (the one with four threads) than the Dual-Core AMD Opteron 285-based server.

Figure 6 details the power consumption, in watts, of the test servers while idle and during the median peak runs of the benchmark. The Dual-Core Intel Xeon Processor 5160-based server consumed about 29 percent less power while idle than the Dual-Core AMD Opteron 285-based server.

Server	Idle power (watts)	Average power (watts)
64-bit Intel Xeon Processor 3.60 GHz-based server – 2 processors	210.2	336.6
Dual-Core Intel Xeon Processor 5160-based server – 2 processors	192.1	280.1
Dual-Core AMD Opteron 285-based server – 2 processors	271.1	321.0

Figure 6: Average power usage (in watts) of the test servers while idle and during the median peak runs of the SunGard ACR workload. Lower numbers are better

Test methodology

Figure 7 summarizes some key aspects of the configurations of the three server systems; Appendix A provides detailed configuration information.

Server	64-bit Intel Xeon Processor 3.60 GHz-based server	Dual-Core Intel Xeon Processor 5160-based server	Dual-Core AMD Opteron 285-based server
Processor frequency (GHz)	3.6GHz	3.0GHz	2.6GHz
Single/Dual-Core processors	Single	Dual	Dual
Motherboard	Intel SE7520AF2	Intel S5000PSL	UNIWIDE Technologies SS232-128-03
Chipset	Intel E7520 Chipset	Intel 5000P Chipset	NVIDIA nForce4 Chipset
RAM (8GB in each)	8 x 1GB PC2-3200	8 x 1GB PC2-5300 FBDIMM	8 x 1GB PC-3200
Hard Drive	Western Digital WD1600YD	Western Digital WD1600YD	Western Digital WD1600YD

Figure 7: Summary of some key aspects of the server configurations.

Intel configured and provided all three servers.

The difference in RAM types reflects the capabilities of the three motherboards: The Intel SE7520AF2 motherboard offered a shared front-side bus speed of 800 MHz and contained DDR2 PC2-3200 400 MHz memory components. The Intel S5000PSL motherboard offered two independent front-side busses at a speed of 1333 MHz and contained Fully-Buffered DIMM (FBDIMM) modules that used commodity DDR2 PC2-5300 667MHz memory components. The UNIWIDE motherboard supported 184-pin DDR memory, and the highest memory speed available for the Dual-Core AMD Opteron 285-based server was DDR PC3200 400MHz RAM.

Another hardware difference between the servers was the number of processor cores, though all three systems offer four processing threads. The 64-bit Intel Xeon Processor 3.60 GHz-based server contained single-core processors with HT Technology. The Dual-Core Intel Xeon Processor 5160- and Dual-Core AMD Opteron 285-based server contained dual-core processors.

With the following exceptions, we used the default BIOS settings on each server: we disabled the HW Prefetcher and the Adjacent Cache Line Prefetcher on the Dual-Core Intel Xeon Processor 5160-based server. These options were disabled by default on the 64-bit Intel Xeon processor 3.60 GHz-based server and were not available on the Dual-Core AMD Opteron 285-based server.

We began our testing by installing a fresh copy of Microsoft Windows 2003 Server, x64 Enterprise Edition Service Pack 1 on each server. We followed this process for each installation:

1. Assign a computer name of "Server".
2. For the licensing mode, use the default setting of five concurrent connections.
3. Enter a password for the administrator log on.
4. Select Eastern Time Zone.
5. Use typical settings for the Network installation.
6. Use "Testbed" for the workgroup.

We applied the following updates from the Microsoft Windows Update site:

- Security Update for Windows Server 2003 x64 Edition (KB908531)
- Cumulative Security Update for Internet Explorer for Windows Server 2003 x64 Edition (KB912812)
- Security Update for Windows Server 2003 x64 Edition (KB911562)
- Cumulative Security Update for Outlook Express for Windows Server 2003 x64 Edition (KB911567)
- Security Update for Windows Media Player Plug-in (KB911564)
- Security Update for Windows Server 2003 x64 Edition (KB911927)
- Security Update for Windows Server 2003 x64 Edition (KB913446)

- Security Update for Windows Server 2003 x64 Edition (KB908519)
- Security Update for Windows Server 2003 x64 Edition (KB912919)
- 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/.

Power measurement procedure

To record each server's power consumption during each test, we used an Extech Instruments (www.extech.com) 380803 Power Analyzer / Datalogger. We connected the power cord from the server under test to the Power Analyzer's output load power outlet. We then plugged the power cord from the Power Analyzer's input voltage connection into a power outlet.

We used the Power Analyzer's Data Acquisition Software (version 2.11) to capture all recordings. We installed the software on a separate Intel–processor-based PC, which we connected to the Power Analyzer via an RS-232 cable. We captured power consumption at one-second intervals.

To gauge the idle power usage, we recorded the power usage while each server was running the operating system but otherwise idle.

We then recorded the power usage (in watts) for each server during the testing at one-second intervals. To compute the average power usage, we averaged the power usage during the time the server was producing its peak performance results. We call this time the power measurement interval. See Figures 3 (power consumption over time), 5 (power consumption at different thread counts), and 6 (idle and average peak power) for the results of these measurements.

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*   This option 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*   This option 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.

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. Open a DOS command window.
2. Navigate to the C:\Sungard folder.
3. Enter the following command:
   "RiskAnalytics /o <server name >_<# of threads>_<run no.>.txt /t <# of threads>", where
   - <server name> is as appropriate
   - <# of threads> is either 2, 4, or 8 as appropriate
   - <run no.> is either 1, 2, or 3 (we ran each test three times)
4. The workload then starts and opens a monitoring console like the one in Figure 8, but without the results graph (see step 7 for more on that graph).
5. Click Calculate at the top left corner of the window.
6. A "Percentage Complete" progress message displays in the bottom left corner of the status bar.
7. When the workload completes, the monitoring console presents a graph of the results over the course of the test; Figure 8 shows an example. 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. Record this time as the primary result of each test.

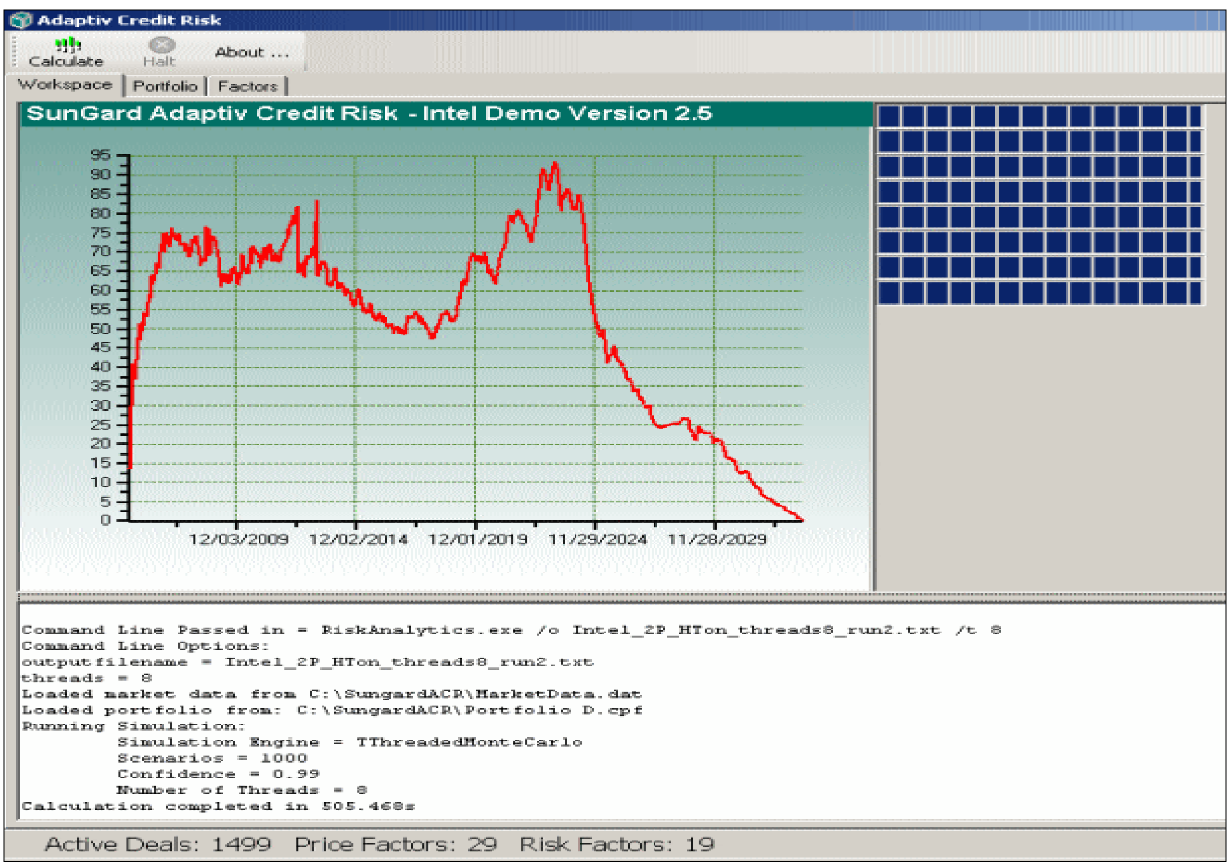

Figure 8: An example of the monitoring console after the SunGard ACR workload completes.

Appendix A – Test server configuration information

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

Processors	64-bit Intel Xeon Processor 3.60 GHz	Dual-Core Intel Xeon Processor 5160	Dual-Core AMD Opteron 285
System configuration information			
General			
Processor and OS kernel: (physical, core, logical) / (UP, MP)	2P2C4L / MP	2P4C4L / MP	2P4C4L / MP
Number of physical processors	2	2	2
Single/Dual-Core processors	Single	Dual	Dual
System Power Management Policy	Always On	Always On	Always On
CPU			
Vendor	Intel	Intel	AMD
Name	64-bit Intel Xeon Processor 3.60 GHz	Dual-Core Intel Xeon Processor 5160	Dual-Core AMD Opteron 285
Stepping	3	4	2
Socket type	mPGA-604	LGA 775	940
Core frequency (GHz)	3.6 GHz	3.0 GHz	2.6 GHz
Front-side bus frequency (MHz)	800 MHz	1333 MHz Dual Independent Busses (DIB)	2000 MHz HyperTransport
L1 Cache	16KB + 12KB	32KB + 32KB	64KB + 64KB
L2 Cache	2MB	4MB (Shared)	2MB (1MB per core)
Platform			
Vendor and model number	64-bit Intel Xeon Processor 3.60 GHz server	Dual-Core Intel Xeon Processor 5160 server	Dual-Core AMD Opteron 285 server
Motherboard model number	Intel SE7520AF2	Intel S5000PSL	UNIWIDE_SS232-128-03
Motherboard chipset	Intel E7520 Chipset	Intel 5000P Chipset	NVIDIA nForce4 Chipset
Motherboard revision number	C4	92	A3
Motherboard serial number	KRA145100053	QTFMHN61400072	WTOPHTSA01020
BIOS name and version	American Megatrends Inc. SE7520AF20.86B.P.10.00.0109.02082006139	American Megatrends Inc. S5000.86B.01.00.0036, 4/4/2006	American Megatrends Inc. 080012, 3/21/2006
BIOS settings	Default	HW Prefetcher and Adjacent Cache Line Prefetcher disabled	Default
Chipset INF driver	7.2.2.1006	7.3.0.1010	6.7
Memory module(s)			
Vendor and model number	Infineon HYS72T128000HR-5-A	Micron MT18HTF12872FDY	Corsair CMX1024RE-32000
Type	PC2-3200	FB-DIMM using PC2-5300 components	PC-3200

Speed (MHz)	400MHz	667MHz	400MHz
Speed in the system currently running @ (MHz)	400MHz	667MHz	400MHz
Timing/Latency (tCL-tRCD-iRP-tRASmin)	3-3-3-11	5-5-5-12	3-3-3-8
Size	8192MB	8192MB	8192MB
Number of RAM modules	8	8	8
Chip organization	Double-sided	Double-sided	Double-sided
Channel	Single	Dual	Dual
Hard disk			
Vendor and model number	Western Digital WD1600YD	Western Digital WD1600YD	Western Digital WD1600YD
Number of disks in system	1	1	1
Size	160GB	160GB	160GB
Buffer Size	16MB	16MB	16MB
RPM	7200	7200	7200
Type	SATA	SATA	SATA
Controller	Intel 82801EB Ultra ATA	Intel 631xESB Serial ATA	NVIDIA nForce4 Serial ATA
Controller driver	Intel 6.3.0.1005	Intel 7.3.0.1010	NVIDIA 5.10.2600.552
Operating system			
Name	Microsoft Windows 2003 Server, x64 Enterprise Edition	Microsoft Windows 2003 Server, x64 Enterprise Edition	Microsoft Windows 2003 Server, x64 Enterprise Edition
Build number	3790	3790	3790
Service Pack	SP1	SP1	SP1
Microsoft Windows update date	5/5/2006	5/5/2006	5/5/2006
File system	NTFS	NTFS	NTFS
Kernel	ACPI Multiprocessor x64-based PC	ACPI Multiprocessor x64-based PC	ACPI Multiprocessor x64-based PC
Language	English	English	English
Microsoft DirectX version	DirectX 9.0c	DirectX 9.0c	DirectX 9.0c
Graphics			
Vendor and model number	ATI Rage XL	ATI ES1000	ATI Rage XL
Chipset	ATI Rage XL PCI	ATI ES1000 PCI	ATI Rage XL PCI
BIOS version	GR-xlints3y.019-4.333	BK-ATI VER008.005.023.000	GR-xlacrs3p.003-4.328
Type	Integrated	Integrated	Integrated
Memory size	8MB	8MB	8MB
Resolution	1024 x 768	1024 x 768	1024 x 768
Driver	ATI 6.14.10.6024	ATI 6.14.10.6553	ATI 6.14.10.6025
Network card/subsystem			
Vendor and model number	Intel PRO/1000 MT Dual Port Network adapter	Intel PRO/1000 EB Network Connection	Broadcom dual NetXtreme Gigabit
Type	Integrated	Integrated	Integrated
Driver	Intel 8.6.17.0	Intel 9.3.28.0	Broadcom 8.48.0.0
Additional card information	2 x Intel PRO/1000 PT Dual Port Server Adapter	2 x Intel PRO/1000 PT Dual Port Server Adapter	2 x Intel PRO/1000 PT Dual Port Server Adapter
Additional card type	PCI – Express	PCI – Express	PCI – Express

Additional card driver	Intel 9.3.28.0	Intel 9.3.28.0	Intel 9.3.28.0
Optical drive			
Vendor and model number	Samsung TS-H325A	LITE-ON SOHD-16P9SV	Samsung SN-124
Type	DVD/CD-ROM	DVD/CD-ROM	CD-ROM
Interface	Internal	Internal	Internal
USB ports			
# of ports	5	6	4
Type of ports (USB 1.1, USB 2.0)	USB 2.0	USB 2.0	USB 2.0

Figure 9: Detailed system configuration information for the three test servers.

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