Principled Technologies®

TEST REPORT
SEPTEMBER 2007

SPEC CPU2006 SPECint_rate_base performance on Red Hat Enterprise Linux 5.1 and 3 AS Intel-based servers

Executive summary

Red Hat, Inc. (Red Hat) commissioned Principled Technologies (PT) to measure the SPEC CPU2006 SPECint_rate_base performance of the following three systems:

- Red Hat Enterprise Linux AS 3 server on the Dual-Core Intel Xeon processor 7140M-based (3.4 GHz) server
- Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server on the Quad-Core Intel Xeon processor X7350-based (2.93 GHz) server
- Red Hat Enterprise Linux 5.1 server on the Quad-Core Intel Xeon processor X7350-based (2.93 GHz) server

SPEC CPU2006 is an industry-standard benchmark created by the Standard Performance Evaluation Corp. (SPEC) to measure a server's compute-intensive performance. The benchmark consequently stresses the CPU and memory subsystems of the system under test. (For more information on SPEC CPU2006 and other SPEC benchmarks, see www.spec.org.)

KEY FINDINGS

- Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server delivered 126.9 percent more performance than Red Hat Enterprise Linux AS 3 Dual-Core Intel Xeon processor 7140M-based server (see Figure 1).
- Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server delivered a 104.5 percent performance increase over Red Hat Enterprise Linux AS 3 on the Dual-Core Intel Xeon processor 7140M-based server (see Figure 1).
- Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server only delivered 9.9 percent less performance than running native on Red Hat Enterprise Linux 5.1 on the same server (see Figure 1).

The SPEC CPU2006 benchmark consists of two benchmark suites, each of which focuses on a different aspect of compute-intensive performance. CINT2006 measures and compares compute-intensive integer performance, while CFP2006 measures and compares compute-intensive floating-point performance. A "rate" version of each, which runs multiple instances of the benchmark to assess server throughput, is also available. We ran only the CINT2006 SPECint_rate_base benchmark.

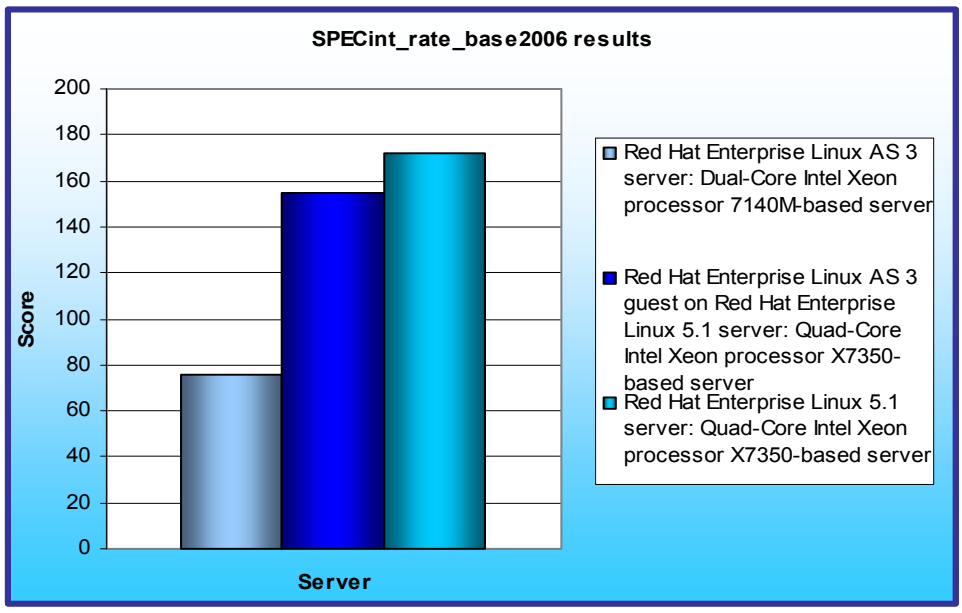


Figure 1: SPECint_rate_base2006 results of the test servers. Higher numbers are better.

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 shows the SPECint_rate_base2006 peak performance of each system. Each result is the median peak score of three runs of the benchmark. See the Test results section for the scores from all three runs. A higher SPECint_rate_base2006

score indicates the server is able to handle a greater load. Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server produced the highest score, 172.0, while Red Hat Enterprise Linux AS 3 Dual-Core Intel Xeon processor 7140M-based server achieved a score of 75.8. The Red Hat Enterprise Linux 5.1 server thus delivered a 126.9 percent performance increase over the Red Hat Enterprise Linux AS 3 server. Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server achieved a score of 155.0, which is only 9.9 percent slower than running native, but a 104.5 percent performance increase over the Red Hat Enterprise Linux AS 3 server.

Workload

The SPEC CPU2006 workload includes two benchmark suites: CINT2006 and CFP2006. We ran only the CINT2006 benchmark, which focuses on measuring and comparing compute-intensive integer performance. Specifically, we measured the SPECint_rate_base2000 results for the test servers with 16 users.

Generally, a system achieves the best SPECint_rate_base2006 score using the same number of users as execution units for a given server. The optimum user count for our testing on all three systems was 16, the number of execution units (logical or physical processors) on those servers.

Figure 2 lists the 12 applications that compose the CINT2006 benchmark. SPEC wrote nine of the applications in C and three (471.omnetpp, 473.astar, 483.xalancbmk) in C++.

Name	Application area
400.perlbench	Programming language
401.bzip2	Compression
403.gcc	C compiler
429.mcf	Combinatorial optimization
445.gobmk	Artificial intelligence: Go
456.hmmer	Search gene sequence
458.sjeng	Artificial intelligence: chess
462.libquantum	Physics/quantum computing
464.h264ref	Video compression
471.omnetpp	Discrete event simulation
473.astar	Path-finding algorithms
483.xalancbmk	XML processing

Figure 2: The applications that make up the CINT2006 benchmark.

A CINT2006 run performs each of the 12 application (tasks) three times and reports the median for each. It also calculates the geometric mean of those 12 results to produce an overall score.

Test results

Figure 3 details the results of our tests with 16 users for SPECint_rate_base2006. We determined the number of users based on the number of execution units in a given server. We used the same number of SPECint_rate_base2006 users as processor execution units, so there is a one-to-one ratio.

SPECint_rate_base2006 performs three runs of each benchmark in the test suite and records the median, so the final score is a median of three runs. Higher scores are better.

Server	SPECint_rate_base2006 results
Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server	75.8
Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	155.0
Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	172.0

Figure 3: SPECint_rate_base2006 results for the three systems under test. Higher numbers are better.

Test methodology

Figure 4 summarizes some of the key aspects of the configurations of the server systems; Appendix A provides detailed configuration information.

Server	Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server	Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server
Processor frequency (GHz)	3.4 GHz	2.93 GHz	2.93 GHz
Front-side bus frequency (MHz)	800 MHz	1,066 MHz	1,066 MHz
Number of processor packages	4	4	4
Number of cores per processor package	2	4	4
Number of hardware threads per core	2	1	1
Motherboard	Intel SE8500HW4	Intel S7000FC4UR	Intel S7000FC4UR
Chipset	Intel SE8500	Intel ID3600	Intel ID3600
RAM (32 GB in each)	32 GB (16 x 2GB) PC2-3200 DDR2	32 GB (16 x 2GB) PC2-5300 FB-DDR2	32 GB (16 x 2GB) PC2-5300 FB-DDR2
Hard Drive	Seagate ST3146854LC	Seagate ST973401SS	Seagate ST973401SS

Figure 4: Summary of some key aspects of the server configurations.

Red Hat configured and provided all servers.

We began by installing a fresh copy of Red Hat Enterprise Linux on the test systems. For the RHEL 3 installation, we used all default settings except for disabling the firewall. For the RHEL 5.1 installation, we installed only the Software Development package, and disabled the firewall and SELinux. We used the same installation method for the RHEL 3 guest on RHEL 5.1; however, during this installation we elected to install virtualization. We made no additional changes to the default installation options.

With the following exceptions, we used the default BIOS settings on each server: disabling HW Prefetcher and Adjacent Cache Line Prefetcher and enabling High Bandwidth on the Red Hat Enterprise Linux AS 3 guest on

Red Hat Enterprise Linux 5.1 server and Red Hat Enterprise Linux 5.1 server. We enabled HW Prefetcher and Adjacent Cache Line Prefetcher on the Red Hat Enterprise Linux AS 3 server.

SPECCPU2006 configuration

We followed SPEC's standard instructions for building the CINT2006 executables. After studying the best results for this benchmark on the SPEC Web site, we chose the following software tools:

- Intel C/C++ Compiler 10.0.025 for EM64T

The benchmark requires configuration files. From the SPEC Web site we chose the most recent (as of the testing for this report) SPECCPU2006 results that used the above compiler. We copied the configuration files for those results and used them, with modifications to reflect the appropriate system information about the server under test, in our testing. The configuration files we used appear in Appendix B.

We report only the base metrics for the SPECint_rate test. SPEC requires the base metrics for all reported results and sets compilation guidelines that testers must follow in building the executables for such tests.

To begin the benchmark, we performed the following steps:

- Open a command prompt.
- Change to the cpu2006 directory.
- Type ". ./shrc" at the command prompt.
- Enter "runspec -c <config file name> -r 16 -T base -v 10 int" where
  - <config file name> = name of the configuration file
  - Where 16 = number of users

When the run completes, the benchmark puts the results in the directory \cpu2006\result. The result file names are of the form CINT2006.<number>.<suffix>. The suffixes are html, asc, raw, and pdf. The number is three digits and associates a result file with its log, e.g. CINT2006.002. asc and log.002.

Appendix A – Test system configuration information

This appendix provides detailed configuration information about each of the test server systems, which we list in alphabetical order.

Servers	Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server	Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server
General processor setup			
Number of processor packages	4	4	4
Number of cores per processor package	2	4	4
Number of hardware threads per core	2	1	1
CPU			
Vendor	Intel	Intel	Intel
Name	Dual-Core Intel Xeon MP 7140M	Quad-Core Intel Xeon X7350	Quad-Core Intel Xeon X7350
Stepping	8	B	B
Socket type	mPGA604	mPGA604	mPGA604
Core frequency (GHz)	3.4 GHz	2.93 GHz	2.93 GHz
Front-side bus frequency (MHz)	800 MHz	1,066 MHz	1,066 MHz
L1 Cache	12 KB + 16 KB (per core)	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)
L2 Cache	2 x 1 MB	2 x 4 MB (each 4 MBs shared by 2 cores)	2 x 4 MB (each 4 MBs shared by 2 cores)
L3 Cache	16 MB	NA	NA
Platform			
Vendor and model number	Intel	Intel	Intel
Motherboard model number	SR4850HW4x	S7000FC4UR	S7000FC4UR
Motherboard chipset	Intel SE8501	Intel ID3600	Intel ID3600
Motherboard revision number	11	01	01
BIOS name and version	Intel Corporation SHW40.86B.P.12.00.0076, 02/15/2007	Intel SFC4UR.86B.01.00.0010.050420071510	Intel SFC4UR.86B.01.00.0010.050420071510
BIOS settings	Disabled HW Prefetcher/enabled adjacent cache line Prefetcher	Disabled HW Prefetcher and adjacent cache line Prefetcher/enabled high bandwidth	Disabled HW Prefetcher and adjacent cache line Prefetcher/enabled high bandwidth
Memory module(s)			
Vendor and model number	Kingston KVR400D2D4R3/2GB	Samsung M395T5750EZ4-CE66	Samsung M395T5750EZ4-CE66
Type	PC2-3200 DDR2	PC2-5300 FB-DDR2	PC2-5300 FB-DDR2
Speed (MHz)	400 MHz	667 MHz	667 MHz
Speed in the system currently running @ (MHz)	400 MHz	667 MHz	667 MHz

Servers	Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server	Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server
Timing/Latency (tCL-tRCD-iRP-tRASmin)	3-3-3-9	5-5-5-15	5-5-5-15
Size	32,768 MB	32,768 MB	32,768 MB
Number of RAM modules	16	16	16
Chip organization	Double-sided	Double-sided	Double-sided
Hard disk			
Vendor and model number	Seagate ST3146854LC	Seagate ST973401SS	Seagate ST973401SS
Number of disks in system	1	1	1
Size	146.8 GB	73.4 GB	73.4 GB
Buffer Size	8 MB	8 MB	8 MB
RPM	15,000	10,000	10,000
Type	SCSI	SAS	SAS
Controller	LSI Logic PCI-X Ultra320 SCSI	Intel 631xESB/6321ESB/3100 Chipset Serial ATA Storage Controller – 2680	Intel 631xESB/6321ESB/3100 Chipset Serial ATA Storage Controller – 2680
Operating system			
Name	Red Hat Enterprise Linux 3 Advanced Server	Red Hat Enterprise Linux 5 Advanced Server	Red Hat Enterprise Linux 5 Advanced Server
Build number	RHEL 3 update 9	RHEL 5.1/RHEL 3 update 9	RHEL 5.1
File system	ext3	ext3	ext3
Kernel	2.4.21-50.EL (x86_64)	2.4.21-50.EL (x86_64)	2.6.18-36.el5 (x86_64)
Language	English	English	English
Graphics			
Vendor and model number	ATI Radeon 7000	ATI ES1000	ATI ES1000
Chipset	ATI Radeon 7000 PCI	ES1000	ES1000
BIOS version	BK-ATI VER008.004.037.001	BK-ATI VER008.005.031.000	BK-ATI VER008.005.031.000
Type	Integrated	Integrated	Integrated
Memory size	16 MB	32 MB	32 MB
Resolution	1024x768	1024x768	1024x768
Network card/subsystem			
Vendor and model number	Broadcom BCM5704 dual NetXtreme Gigabit Adapter	Intel PRO/1000 EB/Intel 82575EB	Intel PRO/1000 EB/Intel 82575EB
Type	Integrated	Integrated	Integrated
Optical drive			
Vendor and model number	Philips SDR089	Optiarc DVD-ROM DDU810A	Optiarc DVD-ROM DDU810A

Servers	Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server	Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server
USB ports			
Number	5	5	5
Type	USB 2.0	USB 2.0	USB 2.0

Figure 5: Detailed system configuration information for the three test servers.

Appendix B – SPECint_rate_base2006 configuration files

This appendix contains the benchmark configuration files we used to test the servers.

Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server

```
# Invocation command line:
# /usr/cpu2006/bin/runspec -c RHEL3x64_ic10.0_em64t_Aug272007.cfg -T base -r 16 -o all -v 10 int
# output_root was not used for this run
############################################################################
############################################################
# SPEC CPU2006 v1.0 Intel RHEL5 x64 (64-bit) config file     #
# Aug 27 2007 Intel Compiler 10.0 for Linux Intel EM64T       #
############################################################

action      = validate
tune        = base
ext         = RHEL3x64_ic10.0_em64t_Aug272007
PATHSEP     = /
flagsurl    = http://www.spec.org/cpu2006/flags/FSC_Intel_flags.xml.xml

check_md5   = 1
mean_anyway = 1
reportable  = 1

############################################################################
# System information                                                       #
# If some remarks about BIOS or Firmware are needed, place them here. #
############################################################################

default=default=default=default:
notes_os_000= 'ulimit -s unlimited' was used to set the stacksize to unlimited prior to run
#notes_os_005= '/usr/bin/taskset' used to bind processes to CPUs
notes_000=
notes_005= The system bus runs at 800 MHz
notes_010=
notes_015=
notes_020= BIOS configuration:
notes_025= Hardware Prefetch = Enable, Adjacent Sector Prefetch = Enable
notes_030=

####################################
# Description Hardware and Software #
####################################

default=default=default=default:
hw_vendor          =
hw_model000        =
hw_model001        =
```

```
hw_cpu_name        =
hw_cpu_char        =
hw_cpu_mhz         =
hw_fpu             =
#
hw_nchips          =
hw_ncores          =
hw_ncoresperchip   =
hw_nthreadspercore =
#
hw_ncpuorder       =
hw_pcache          =
hw_scache          =
hw_tcache          =
hw_ocache          =
hw_memory000       =
hw_memory001       =
hw_disk            =
hw_other           =
sw_file            =
sw_state           =
license_num        =
test_sponsor       =
tester             =
test_date          =
hw_avail           =
prepared_by        =
config             =


default=default=default=default:
CC  = icc
CXX = icpc
FC  = ifort
OBJ = .o

SMARTHEAP_DIR = /opt/SmartHeap_8_1/lib

submit= MYMASK=`printf '0x%x' \$((1<<\$SPECCOPYNUM))`; /usr/bin/taskset \$MYMASK -- $command

############################
# portability & libraries #
############################

fp=default=default=default:
PORTABILITY = -DSPEC_CPU_LP64

400.perlbench=default=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX_X64

403.gcc=default=default=default:
EXTRA_CFLAGS = -Dalloca=_alloca

462.libquantum=default=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX

483.xalancbmk=default=default=default:
CXXPORTABILITY = -DSPEC_CPU_LINUX

435.gromacs=default=default=default:
LDPORTABILITY = -nofor_main

436.cactusADM=default=default=default:
LDPORTABILITY = -nofor_main

454.calculix=default=default=default:
LDPORTABILITY = -nofor_main

481.wrf=default=default=default:
CPORTABILITY = -DSPEC_CPU_CASE_FLAG -DSPEC_CPU_LINUX
```

```
#########################
# Baseline Tuning Flags #
#########################

int=base=default=default:
COPTIMIZE= -xP -O3 -ipo -no-prec-div -static
CXXOPTIMIZE= -xP -O3 -ipo -no-prec-div -ansi-alias
EXTRA_CXXLIBS= -L$(SMARTHEAP_DIR) -lsmartheap

fp=base=default=default:
OPTIMIZE= -xP -O3 -ipo -no-prec-div -static

####################
# Peak Tuning Flags #
####################

int=peak=default=default:
basepeak=yes
fp=peak=default=default:
basepeak=yes

#########################
# Used Compilers and OS #
#########################

int=default=default=default:
sw_compiler000   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler001   = Version 10.0 - Build 20070613,
sw_compiler002   = Package-ID: l_cc_c_10.0.025
sw_other         = Smart Heap Library, Version 8.1
sw_base_ptrsize  = 32-bit

fp=default=default=default:
sw_compiler001   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler002   = Version 10.0 - Build 20070613,
sw_compiler003   = Package-ID: l_cc_c_10.0.025
sw_compiler004   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler005   = Version 10.0 - Build 20070613,
sw_compiler006   = Package-ID: l_fc_c_10.0.025
sw_other         = None
sw_base_ptrsize  = 64-bit

default=default=default=default:
sw_os000        = Red Hat Enterprise Linux AS 3 (Update 9)
sw_os001        = Kernel 2.4.21-50.EL (x86_64)
sw_avail       = Aug-2007
sw_auto_parallel = No

######################
# End of config-file #
######################
```

Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server

```
# Invocation command line:
# /usr/cpu2006/bin/runspec -c RHEL3xen-x64_ic10.0_em64t_Aug272007.cfg -T base -r 16 -o all -v 10 int
# output_root was not used for this run
############################################################################
############################################################
# SPEC CPU2006 v1.0 Intel RHEL5 x64 (64-bit) config file     #
# Aug 27 2007 Intel Compiler 10.0 for Linux Intel EM64T       #
############################################################

action      = validate
```

```
tune        = base
ext         = RHEL3xen-x64_ic10.0_em64t_Aug272007
PATHSEP     = /
flagsurl    = http://www.spec.org/cpu2006/flags/FSC_Intel_flags.xml.xml

check_md5   = 1
mean_anyway = 1
reportable  = 1

################################################################################
# System information                                                           #
# If some remarks about BIOS or Firmware are needed, place them here. #
################################################################################

default=default=default=default:
#notes_os_000= 'ulimit -s unlimited' was used to set the stacksize to unlimited prior to run
notes_os_000= '/bin/taskset' used to bind processes to CPUs
notes_000=
notes_005=
notes_010= BIOS configuration:
notes_015= Hardware Prefetch = Disable, Adjacent Sector Prefetch = Disable

#####################################
# Description Hardware and Software #
#####################################

default=default=default=default:
hw_vendor          =
hw_model000        =
hw_model001        =
hw_cpu_name        =
hw_cpu_char        =
hw_cpu_mhz         =
hw_fpu             =
#
hw_nchips          =
hw_ncores          =
hw_ncoresperchip   =
hw_nthreadspercore =
#
hw_ncpuorder       =
hw_pcache          =
hw_scache          =
hw_tcache          =
hw_ocache          =
hw_memory000       =
hw_memory001       =
hw_disk            =
hw_other           =

sw_file            =
sw_state           =

license_num        =
test_sponsor       =
tester             =
test_date          =
hw_avail           =
prepared_by        =
config             =

default=default=default=default:
CC  = icc
CXX = icpc
FC  = ifort
OBJ = .o

SMARTHEAP_DIR = /opt/SmartHeap_8_1/lib

#submit= MYMASK=`printf '0x%x' \$((1<<\$SPECCOPYNUM))`; /bin/taskset \$MYMASK $command
```

```
############################
# portability & libraries #
############################

fp=default=default=default:
PORTABILITY = -DSPEC_CPU_LP64

400.perlbench=default=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX_IA32

403.gcc=default=default=default:
CPORTABILITY = -DSPEC_CPU_NEED_ALLOCA_H
#EXTRA_CFLAGS = -Dalloca=_alloca

462.libquantum=default=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX

483.xalancbmk=default=default=default:
CXXPORTABILITY = -DSPEC_CPU_LINUX

435.gromacs=default=default=default:
LDPORTABILITY = -nofor_main

436.cactusADM=default=default=default:
LDPORTABILITY = -nofor_main
PORTABILITY = -DSPEC_CPU_LP64

454.calculix=default=default=default:
LDPORTABILITY = -nofor_main

481.wrf=default=default=default:
CPORTABILITY = -DSPEC_CPU_CASE_FLAG -DSPEC_CPU_LINUX

#########################
# Baseline Tuning Flags #
#########################

int=base=default=default:
COPTIMIZE= -fast
CXXOPTIMIZE= -xT -O3 -ipo -no-prec-div -ansi-alias
EXTRA_CXXLIBS= -L$(SMARTHEAP_DIR) -lsmartheap

fp=base=default=default:
OPTIMIZE= -fast

######################
# Peak Tuning Flags #
######################

int=peak=default=default:
basepeak=yes
fp=peak=default=default:
basepeak=yes

#########################
# Used Compilers and OS #
#########################

int=default=default=default:
sw_compiler000   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler001   = Version 10.0 - Build 20070613,
sw_compiler002   = Package-ID: l_cc_c_10.0.025
sw_other         = Smart Heap Library, Version 8.1
sw_base_ptrsize  = 32-bit

fp=default=default=default:
sw_compiler001   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler002   = Version 10.0 - Build 20070613,
sw_compiler003   = Package-ID: l_cc_c_10.0.025
```

```
sw_compiler004   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler005   = Version 10.0 - Build 20070613,
sw_compiler006   = Package-ID: l_fc_c_10.0.025
sw_other         = None
sw_base_ptrsize  = 64-bit

default=default=default=default:
sw_os000        = Red Hat Enterprise Linux AS 3 (Update 9)
sw_os001        = Kernel 2.4.21-50.EL (x86_64)
sw_avail       = Aug-2007
sw_auto_parallel = No

######################
# End of config-file #
######################
```

Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server

```
# Invocation command line:
# /usr/cpu2006/bin/runspec -c RHEL5.1x64_ic10.0_em64t_Aug272007.cfg -T base -r 16 -o all -v 10 int
# output_root was not used for this run
############################################################################
############################################################
# SPEC CPU2006 v1.0 Intel RHEL5 x64 (64-bit) config file     #
# Aug 27 2007 Intel Compiler 10.0 for Linux Intel EM64T       #
############################################################

action      = validate
tune        = base
ext         = RHEL5.1x64_ic10.0_em64t_Aug272007
PATHSEP     = /
flagsurl    = http://www.spec.org/cpu2006/flags/FSC_Intel_flags.xml.xml

check_md5   = 1
mean_anyway = 1
reportable  = 1

############################################################################
# System information                                                       #
# If some remarks about BIOS or Firmware are needed, place them here. #
############################################################################

default=default=default=default:
notes_os_000= 'ulimit -s unlimited' was used to set the stacksize to unlimited prior to run
#notes_os_005= '/bin/taskset' used to bind processes to CPUs
notes_000=
notes_005=
notes_010= BIOS configuration:
notes_015= Hardware Prefetch = Disable, Adjacent Sector Prefetch = Disable

####################################
# Description Hardware and Software #
####################################

default=default=default=default:
hw_vendor          =
hw_model000        =
hw_model001        =
hw_cpu_name        =
hw_cpu_char        =
hw_cpu_mhz         =
hw_fpu             =
#
hw_nchips          =
hw_ncores          =
hw_ncoresperchip   =
hw_nthreadspercore =
```

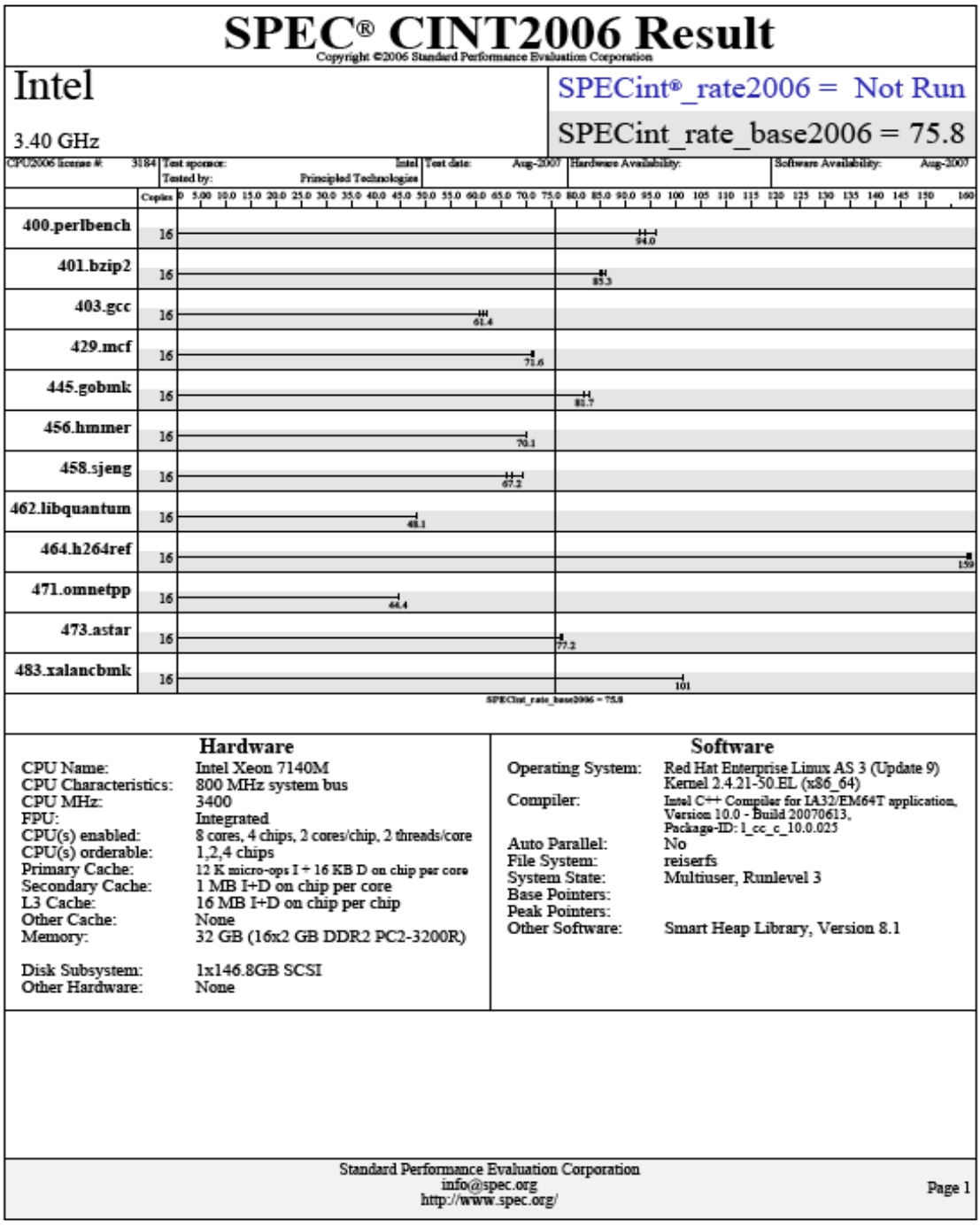
```
#
hw_ncpuorder       =
hw_pcache          =
hw_scache          =
hw_tcache          =
hw_ocache          =
hw_memory000       =
hw_memory001       =
hw_disk            =
hw_other           =

sw_file            =
sw_state           =

license_num        =
test_sponsor       =
tester             =
test_date          =
hw_avail           =
prepared_by        =
config             =

default=default=default=default:
CC  = icc
CXX = icpc
FC  = ifort
OBJ = .o

SMARTHEAP_DIR = /opt/SmartHeap_8_1/lib

#submit= MYMASK=`printf '0x%x' \$((1<<\$SPECCOPYNUM))`; /bin/taskset \$MYMASK $command

############################
# portability & libraries #
############################

fp=default=default=default:
PORTABILITY = -DSPEC_CPU_LP64

400.perlbench=default=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX_IA32

403.gcc=default=default=default:
EXTRA_CFLAGS = -Dalloca=_alloca

462.libquantum=default=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX

483.xalancbmk=default=default=default:
CXXPORTABILITY = -DSPEC_CPU_LINUX

435.gromacs=default=default=default:
LDPORTABILITY = -nofor_main

436.cactusADM=default=default=default:
LDPORTABILITY = -nofor_main
PORTABILITY = -DSPEC_CPU_LP64

454.calculix=default=default=default:
LDPORTABILITY = -nofor_main

481.wrf=default=default=default:
CPORTABILITY = -DSPEC_CPU_CASE_FLAG -DSPEC_CPU_LINUX

#########################
# Baseline Tuning Flags #
#########################

int=base=default=default:
COPTIMIZE= -fast
```

```
CXXOPTIMIZE= -xT -O3 -ipo -no-prec-div -ansi-alias
EXTRA_CXXLIBS= -L$(SMARTHEAP_DIR) -lsmartheap

fp=base=default=default:
OPTIMIZE= -fast

######################
# Peak Tuning Flags #
######################

int=peak=default=default:
basepeak=yes
fp=peak=default=default:
basepeak=yes

#########################
# Used Compilers and OS #
#########################

int=default=default=default:
sw_compiler000   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler001   = Version 10.0 - Build 20070613,
sw_compiler002   = Package-ID: l_cc_c_10.0.025
sw_other         = Smart Heap Library, Version 8.1
sw_base_ptrsize  = 32-bit
sw_peak_ptrsize  = 32/64-bit

fp=default=default=default:
sw_compiler001   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler002   = Version 10.0 - Build 20070613,
sw_compiler003   = Package-ID: l_cc_c_10.0.025
sw_compiler004   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler005   = Version 10.0 - Build 20070613
sw_compiler006   = Package-ID: l_fc_c_10.0.025
sw_other         = None
sw_base_ptrsize  = 64-bit
sw_peak_ptrsize  = 32/64-bit

default=default=default=default:
sw_os000        = Red Hat Enterprise Linux 5.1 (x86_64)
sw_os001        = Kernel 2.6.18-36.el5
sw_avail       = Aug-2007
sw_auto_parallel = No

######################
# End of config-file #
######################
```

Appendix C – SPECint_rate_base2006 output

This appendix provides the output of the benchmark for each of the test servers.

Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server



SPEC® CINT2006 Result

Copyright ©2006 Standard Performance Evaluation Corporation

Intel

3.40 GHz

SPECint®_rate2006 = Not Run

SPECint_rate_base2006 = 75.8

CPU2006 license #: 3184 | Test sponsor: Intel | Test date: Aug-2007 | Hardware Availability: | Software Availability: Aug-2007

Tested by: Principled Technologies

	Copies	0 5.00 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100 105 110 115 120 125 130 135 140 145 150 160
400.perlbench	16	94.0
401.bzip2	16	85.3
403.gcc	16	61.4
429.mcf	16	71.6
445.gobmk	16	86.7
456.hmmer	16	70.1
458.sjeng	16	67.2
462.libquantum	16	48.1
464.h264ref	16	159
471.omnetpp	16	44.4
473.astar	16	77.2
483.xalancbmk	16	101

SPECint_rate_base2006 = 75.8

Hardware

CPU Name:	Intel Xeon 7140M
CPU Characteristics:	800 MHz system bus
CPU MHz:	3400
FPU:	Integrated
CPU(s) enabled:	8 cores, 4 chips, 2 cores/chip, 2 threads/core
CPU(s) orderable:	1,2,4 chips
Primary Cache:	12 K micro-ops I + 16 KB D on chip per core
Secondary Cache:	1 MB I+D on chip per core
L3 Cache:	16 MB I+D on chip per chip
Other Cache:	None
Memory:	32 GB (16x2 GB DDR2 PC2-3200R)
Disk Subsystem:	1x146.8GB SCSI
Other Hardware:	None

Software

Operating System:	Red Hat Enterprise Linux AS 3 (Update 9) Kernel 2.4.21-50.EL (x86_64)
Compiler:	Intel C++ Compiler for IA32/EM64T application, Version 10.0 - Build 20070613, Package-ID: l_cc_c_10.0.025
Auto Parallel:	No
File System:	reiserfs
System State:	Multiuser, Runlevel 3
Base Pointers:	
Peak Pointers:	
Other Software:	Smart Heap Library, Version 8.1

Standard Performance Evaluation Corporation
info@spec.org
http://www.spec.org/

Page 1

SPEC CINT2006 Result

Intel

3.40 GHz

SPECint_rate2006 = Not Run

SPECint_rate_base2006 = 75.8

CPU2006 license #: 3184 | Test sponsor: Intel | Tested by: Principled Technologies | Test date: Aug-2007 | Hardware Availability: | Software Availability: Aug-2007

Results Table

Benchmark	Base							Peak						
	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
400.perlbench	16	1680	92.9	1630	96.0	**1660**	**94.0**							
401.bzip2	16	**1810**	**85.3**	1820	85.0	1800	85.9							
403.gcc	16	**2100**	**61.4**	2080	62.0	2120	60.6							
429.mcf	16	2050	71.3	**2040**	**71.6**	2040	71.7							
445.gobmk	16	**2050**	**81.7**	2030	82.7	2060	81.5							
456.hmmer	16	2130	70.2	**2130**	**70.1**	2130	70.1							
458.sjeng	16	2790	69.4	**2880**	**67.2**	2940	65.9							
462.libquantum	16	6890	48.1	**6890**	**48.1**	6890	48.1							
464.h264ref	16	2230	158	2220	159	**2230**	**159**							
471.omnetpp	16	2260	44.3	**2250**	**44.4**	2250	44.4							
473.astar	16	**1460**	**77.2**	1450	77.3	1460	77.0							
483.xalancbmk	16	1090	101	1090	102	**1090**	**101**							

Results appear in the order in which they were run. Bold underlined text indicates a median measurement.

Operating System Notes

'ulimit -s unlimited' was used to set the stacksize to unlimited prior to run

General Notes

The system bus runs at 800 MHz

BIOS configuration:
Hardware Prefetch = Enable, Adjacent Sector Prefetch = Enable

Base Compiler Invocation

C benchmarks:
icc

C++ benchmarks:
icpc

Base Portability Flags

C benchmarks (except as noted below):
No flags used

Continued on next page

SPEC CINT2006 Result

Intel

3.40 GHz

SPECint_rate2006 = Not Run

SPECint_rate_base2006 = 75.8

CPU2006 license #: 3184	Test sponsor: Intel Tested by: Principled Technologies	Test date: Aug-2007	Hardware Availability:	Software Availability: Aug-2007

Base Portability Flags (Continued)

400.perlbench: -DSPEC_CPU_LINUX_X64

462.libquantum: -DSPEC_CPU_LINUX

C++ benchmarks:

471.omnetpp: No flags used

473.astar: -DSPEC_CPU_LITTLE_ENDIAN

483.xalancbmk: -DSPEC_CPU_LINUX

Base Optimization Flags

C benchmarks:
-O3 -ipo -xP -no-prec-div -static

C++ benchmarks:
-O3 -ansi-alias -ipo -L/opt/SmartHeap_8_1/lib -lsmartheap -xP
-no-prec-div

Base Other Flags

C benchmarks (except as noted below):
No flags used

403.gcc: -Dalloca=_alloca

C++ benchmarks:
No flags used

Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server

SPEC® CINT2006 Result

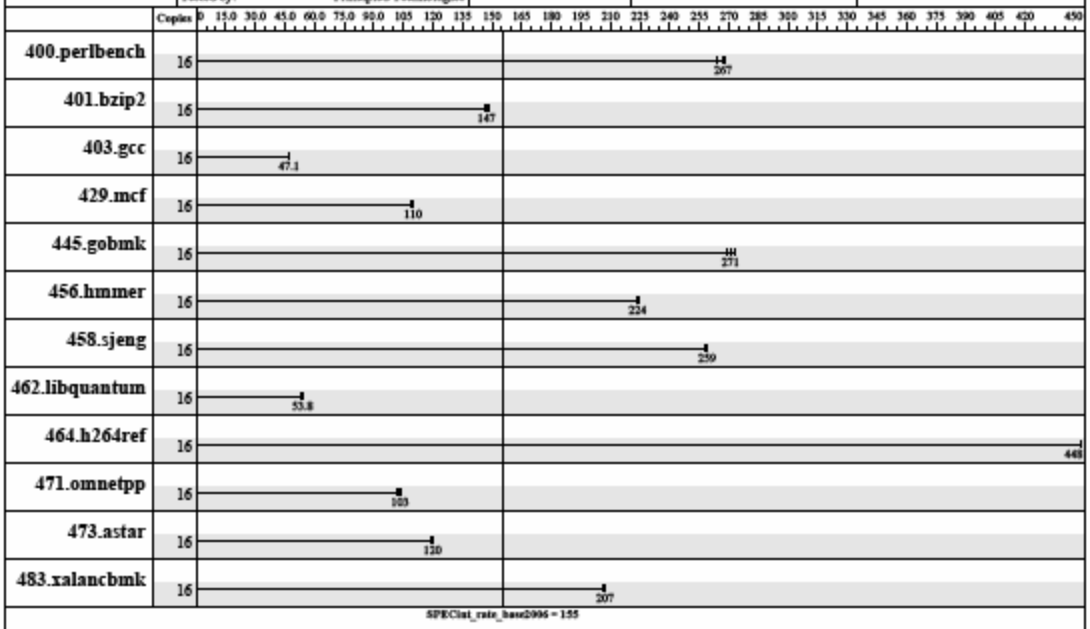
Intel

Intel Xeon processor X7350
2.93 GHz

SPECint®_rate2006 = Not Run

SPECint_rate_base2006 = 155

CPU2006 license #: 3184 | Test sponsor: Intel | Tested by: Principled Technologies | Test date: Aug-2007 | Hardware Availability: Aug-2007 | Software Availability: Aug-2007



Hardware

CPU Name:	Intel Xeon X7350
CPU Characteristics:	1333 MHz system bus
CPU MHz:	3000
FPU:	Integrated
CPU(s) enabled:	16 cores, 4 chips, 4 cores/chip
CPU(s) orderable:	1,2 chips
Primary Cache:	32 KB I + 32 KB D on chip per core
Secondary Cache:	8 MB I+D on chip per chip, 4 MB shared / 2 cores
L3 Cache:	None
Other Cache:	None
Memory:	32 GB (16x2 GB DDR2 PC2-5300F)
Disk Subsystem:	1x73GB SAS
Other Hardware:	None

Software

Operating System:	Red Hat Enterprise Linux AS 3 (Update 9) Kernel 2.4.21-50.EL (x86_64)
Compiler:	Intel C++ Compiler for IA32/EM64T application, Version 10.0 - Build 20070613, Package-ID: l_cc_c_10.0.025
Auto Parallel:	No
File System:	ext2
System State:	Multiuser, Runlevel 3
Base Pointers:	
Peak Pointers:	
Other Software:	Smart Heap Library, Version 8.1

SPEC CINT2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECint_rate2006 = Not Run

SPECint_rate_base2006 = 155

CPU2006 license #: 3184 | Test sponsor: Intel | Tested by: Principled Technologies | Test date: Aug-2007 | Hardware Availability: Aug-2007 | Software Availability: Aug-2007

Results Table

Benchmark	Base							Peak						
	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
400.perlbench	16	**586**	**267**	592	264	584	268							
401.bzip2	16	1040	148	**1050**	**147**	1050	147							
403.gcc	16	2750	46.9	**2730**	**47.1**	2720	47.3							
429.mcf	16	1330	109	**1330**	**110**	1330	110							
445.gobmk	16	**619**	**271**	614	274	625	269							
456.hmmer	16	669	223	664	225	**667**	**224**							
458.sjeng	16	751	258	**748**	**259**	747	259							
462.libquantum	16	6240	53.2	**6160**	**53.8**	6140	54.0							
464.h264ref	16	789	449	790	448	**790**	**448**							
471.omnetpp	16	983	102	**969**	**103**	967	103							
473.astar	16	942	119	**937**	**120**	937	120							
483.xalancbmk	16	**533**	**207**	536	206	532	207							

Results appear in the order in which they were run. Bold underlined text indicates a median measurement.

Operating System Notes

'/bin/taskset' used to bind processes to CPUs

General Notes

BIOS configuration:
Hardware Prefetch = Disable, Adjacent Sector Prefetch = Disable

Base Compiler Invocation

C benchmarks:
icc

C++ benchmarks:
icpc

Base Portability Flags

C benchmarks (except as noted below):
No flags used

400.perlbench: -DSPEC_CPU_LINUX_IA32

Continued on next page

SPEC CINT2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECint_rate2006 = Not Run

SPECint_rate_base2006 = 155

CPU2006 license #: 3184	Test sponsor: Intel Tested by: Principled Technologies	Test date: Aug-2007	Hardware Availability: Aug-2007	Software Availability: Aug-2007

Base Portability Flags (Continued)

403.gcc: -DSPEC_CPU_NEED_ALLOCA_H

462.libquantum: -DSPEC_CPU_LINUX

C++ benchmarks:

471.omnetpp: No flags used

473.astar: -DSPEC_CPU_LITTLE_ENDIAN

483.xalancbmk: -DSPEC_CPU_LINUX

Base Optimization Flags

C benchmarks:
-fast

C++ benchmarks:
-O3 -ansi-alias -ipo -L/opt/SmartHeap_8_1/lib -lsmartheap -xT
-no-prec-div

Base Other Flags

C benchmarks:
No flags used

C++ benchmarks:
No flags used

Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server

SPEC® CINT2006 Result

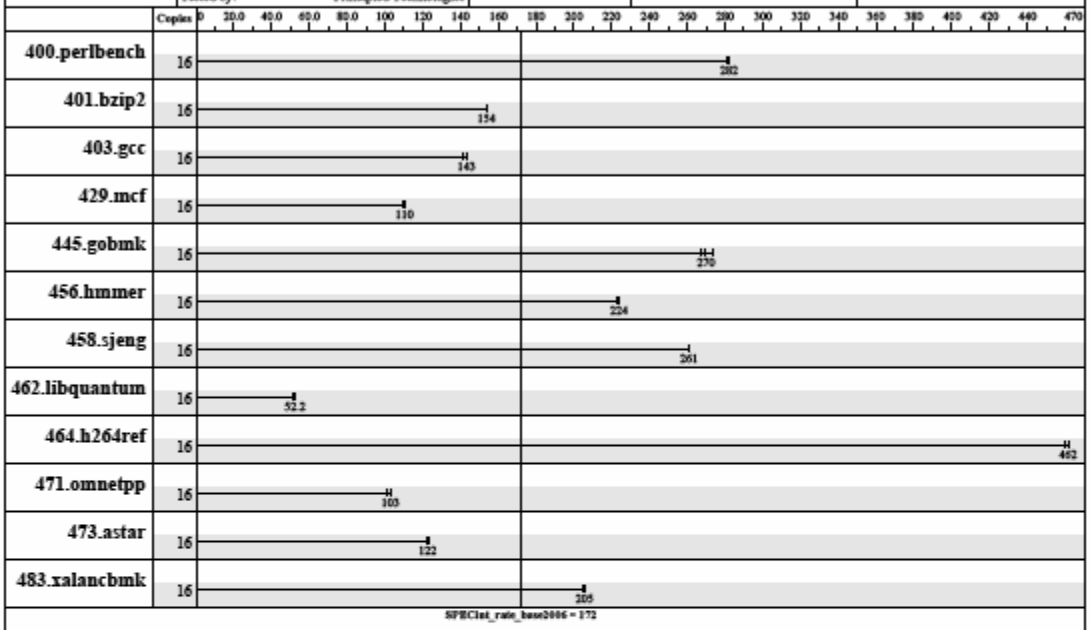
Intel

Intel Xeon processor X7350
2.93 GHz

SPECint®_rate2006 = Not Run

SPECint_rate_base2006 = 172

CPU2006 license #: 3184 | Test sponsor: Intel | Test date: Aug-2007 | Hardware Availability: Aug-2007 | Software Availability: Aug-2007
Tested by: Principled Technologies



Hardware

CPU Name:	Intel Xeon X7350
CPU Characteristics:	1333 MHz system bus
CPU MHz:	3000
FPU:	Integrated
CPU(s) enabled:	16 cores, 4 chips, 4 cores/chip
CPU(s) orderable:	1,2 chips
Primary Cache:	32 KB I + 32 KB D on chip per core
Secondary Cache:	8 MB I+D on chip per chip, 4 MB shared / 2 cores
L3 Cache:	None
Other Cache:	None
Memory:	32 GB (16x2 GB DDR2 PC2-5300F)
Disk Subsystem:	1x73GB SAS
Other Hardware:	None

Software

Operating System:	Red Hat Enterprise Linux 5.1 (x86_64) Kernel 2.6.18-36.el5
Compiler:	Intel C++ Compiler for IA32/EM64T application, Version 10.0 - Build 20070613, Package-ID: l_cc_c_10.0.025
Auto Parallel:	No
File System:	ext2
System State:	Multiuser, Runlevel 3
Base Pointers:	
Peak Pointers:	
Other Software:	Smart Heap Library, Version 8.1

Standard Performance Evaluation Corporation
info@spec.org
http://www.spec.org/

Page 1

SPEC CINT2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECint_rate2006 = Not Run

SPECint_rate_base2006 = 172

CPU2006 license #: 3184 | Test sponsor: Intel | Tested by: Principled Technologies | Test date: Aug-2007 | Hardware Availability: Aug-2007 | Software Availability: Aug-2007

Results Table

Benchmark	Base							Peak						
	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
400.perlbench	16	555	282	**554**	**282**	554	282							
401.bzip2	16	**1000**	**154**	1000	154	1000	154							
403.gcc	16	896	144	912	141	**901**	**143**							
429.mcf	16	1340	109	**1320**	**110**	1320	111							
445.gobmk	16	628	267	615	273	**622**	**270**							
456.hmmer	16	671	222	**667**	**224**	667	224							
458.sjeng	16	743	260	742	261	**742**	**261**							
462.libquantum	16	6450	51.4	**6350**	**52.2**	6310	52.5							
464.h264ref	16	766	462	**767**	**462**	769	460							
471.omnetpp	16	986	101	**971**	**103**	967	103							
473.astar	16	920	122	**918**	**122**	911	123							
483.xalancbmk	16	540	204	**537**	**205**	537	206							

Results appear in the order in which they were run. Bold underlined text indicates a median measurement.

Operating System Notes

'ulimit -s unlimited' was used to set the stacksize to unlimited prior to run

General Notes

BIOS configuration:
Hardware Prefetch = Disable, Adjacent Sector Prefetch = Disable

Base Compiler Invocation

C benchmarks:
icc

C++ benchmarks:
icpc

Base Portability Flags

C benchmarks (except as noted below):
No flags used

400.perlbench: -DSPEC_CPU_LINUX_IA32

Continued on next page

SPEC CINT2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECint_rate2006 = Not Run

SPECint_rate_base2006 = 172

CPU2006 license #: 3184	Test sponsor: Intel Tested by: Principled Technologies	Test date: Aug-2007	Hardware Availability: Aug-2007	Software Availability: Aug-2007

Base Portability Flags (Continued)

462.libquantum: -DSPEC_CPU_LINUX

C++ benchmarks:

471.omnetpp: No flags used

473.astar: -DSPEC_CPU_LITTLE_ENDIAN

483.xalancbmk: -DSPEC_CPU_LINUX

Base Optimization Flags

C benchmarks:
-fast

C++ benchmarks:
-O3 -ansi-alias -ipo -L/opt/SmartHeap_8_1/lib -lsmartheap -xT
-no-prec-div

Base Other Flags

C benchmarks (except as noted below):
No flags used

403.gcc: -Dalloca=_alloca

C++ benchmarks:
No flags used

Principled Technologies, Inc.
1007 Slater Road, Suite 250
Durham, NC 27703
www.principledtechnologies.com
info@principledtechnologies.com