Principled Technologies®

TEST REPORT
SEPTEMBER 2007

SPEC CPU2006 SPECfp_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 SPECfp_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 FINDING

- Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server delivered 82.9 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 70.6 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 delivered only 6.7 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 CFP2006 SPECfp_rate_base benchmark.

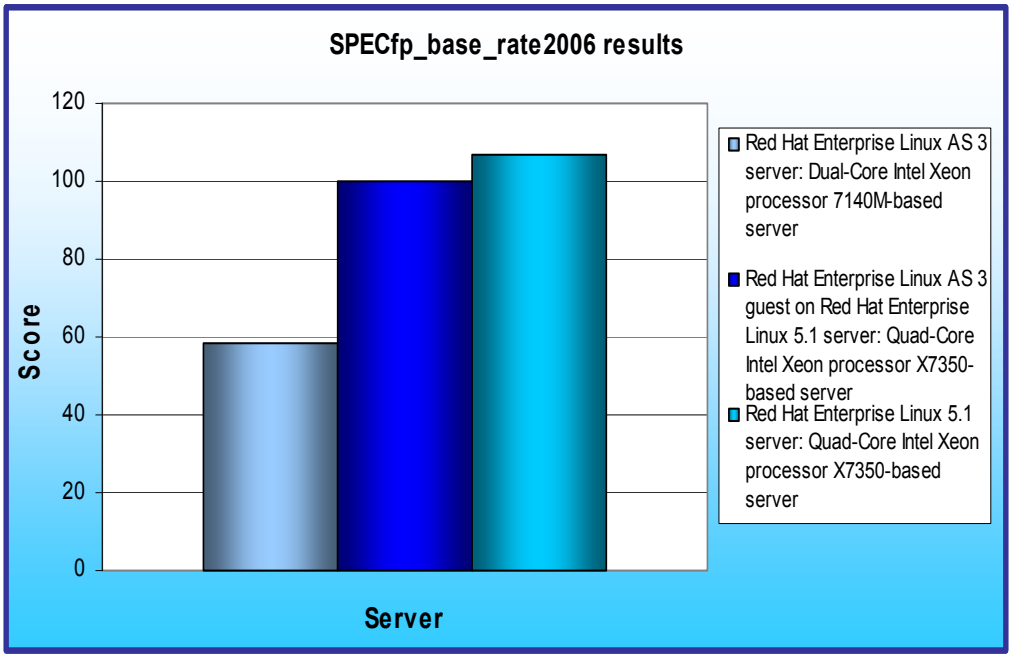


Figure 1: SPECfp_rate_base2006 results of the test servers. Higher numbers are better.

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 SPECfp_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 SPECfp_rate_base2006 score indicates the server can handle a greater load.

Red Hat Enterprise Linux 5.1 on the Quad-Core Intel Xeon processor X7350-based server produced the highest score, 107.0, while Red Hat Enterprise Linux AS 3 Dual-Core Intel Xeon processor 7140M-based server achieved a score of 58.5. The Red Hat Enterprise Linux 5.1 server thus delivered an 82.9 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 99.8, which is only 6.7 percent slower than running native, but a 70.6 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 CFP2006 benchmark, which focuses on measuring and comparing compute-intensive floating-point performance. Specifically, we measured the SPECfp_rate_base2000 results for the test servers with 8 or 16 users.

Generally, a system achieves the best SPECfp_rate_base2006 score using the same number of users as execution units for a given server. The optimum user count for our testing was 8 on the Red Hat Enterprise Linux AS 3 Dual-Core Intel Xeon processor 7140M-based server and 16 on both the Red Hat Enterprise Linux 5.1 Quad-Core Intel Xeon processor X7350-based server and Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 Quad-Core Intel Xeon processor X7350-based server. The difference in user counts between the servers is due to the different number of execution units (logical or physical processors) on those servers. The Dual-Core Intel Xeon processor 7140M-based server would generally have 16 execution units, but we disabled Hyper-Threading Technology for testing, which produces the highest score for this server.

Figure 2 lists the 17 applications that compose the CFP2006 benchmark. SPEC wrote six of the applications in Fortran, three using C, four using both Fortran and C, and four in C++.

Name	Application area
410.bwaves	Fluid Dynamics
416.gamess	Quantum Chemistry
433.mic	Physics/Quantum Chromodynamics
434.zeusmp	Physics/CFD
435.gromacs	Biochemistry/Molecular Dynamics
436.cactusADM	Physics/General Relativity
437.leslie3d	Fluid Dynamics
444.namd	Biology/Molecular Dynamics
447.dealII	Finite Element Analysis
450.soplex	Linear Programming, Optimization
453.povray	Image Ray-tracing
454.calculix	Structural Mechanics
459.GemsFDTD	Computational Electromagnetics
465.tonto	Quantum Chemistry
470.lBM	Fluid Dynamics
481.wrf	Weather
482.sphinx3	Speech recognition

Figure 2: The applications that make up the CFP2006 benchmark.

A CFP2006 run performs each of the 17 application (tasks) three times and reports the median for each. It also calculates the geometric mean of those 17 results to produce an overall score.

Test results

Figure 3 details the results of our tests with 8 and 16 users for SPECfp_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 SPECfp_rate_base2006 users as processor execution units, so there is a one-to-one ratio.

SPECfp_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	SPECfp_rate_base2006 results
Red Hat Enterprise Linux AS 3 server: Dual-Core Intel Xeon processor 7140M-based server	58.5
Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based (2.93 GHz) server	99.8
Red Hat Enterprise Linux 5.1 server: Quad-Core Intel Xeon processor X7350-based server	107.0

Figure 3: SPECfp_rate_base2006 results for the 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 on the Red Hat Enterprise Linux 5.1 and Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 servers. We enabled HW Prefetcher and Adjacent Cache Line Prefetcher, but disabled Hyper-Threading on the Red Hat Enterprise Linux AS 3 server.

SPECCPU2006 configuration

We followed SPEC's standard instructions for building the CFP2006 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
- Intel Fortran 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 SPECfp_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 <#> -T base -v 10 fp" where
  - <config file name> = name of the configuration file
  - <#> = number of users, either 8 or 16

When the run completes, the benchmark puts the results in the directory \cpu2006\result. The result file names are of the form CFP2006.<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. CFP2006.002. 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 and Hyper-Threading/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

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
Optical drive			
Vendor and model number	Philips SDR089	Optiarc DVD-ROM DDU810A	Optiarc DVD-ROM DDU810A
USB ports			
Number	5	5	5
Type	USB 2.0	USB 2.0	USB 2.0

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

Appendix B – SPECfp_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 fp
# 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_other000      = Smart Heap Library, Version 8.1
sw_base_ptrsize  = 32-bit
sw_peak_ptrsize  = 32/64-bit

fp=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_compiler003   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler004   = Version 10.0 - Build 20070613,
sw_compiler005   = 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 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 on the Quad-Core Intel

```
# Invocation command line:
# /usr/cpu2006/bin/runspec -c RHEL3xen-x64_ic10.0_em64t_Aug272007.cfg -T base -r 16 -o all -v 10 fp
# 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/CPU2006_flags.20070417.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))`; /usr/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_other000      = Smart Heap Library, Version 8.1
sw_base_ptrsize  = 32-bit
sw_peak_ptrsize  = 32/64-bit

fp=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_compiler003   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler004   = Version 10.0 - Build 20070613,
sw_compiler005   = Package-ID: l_fc_c_10.0.025
sw_other         = None
sw_base_ptrsize  =
sw_peak_ptrsize  =

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 fp
# 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          =
```

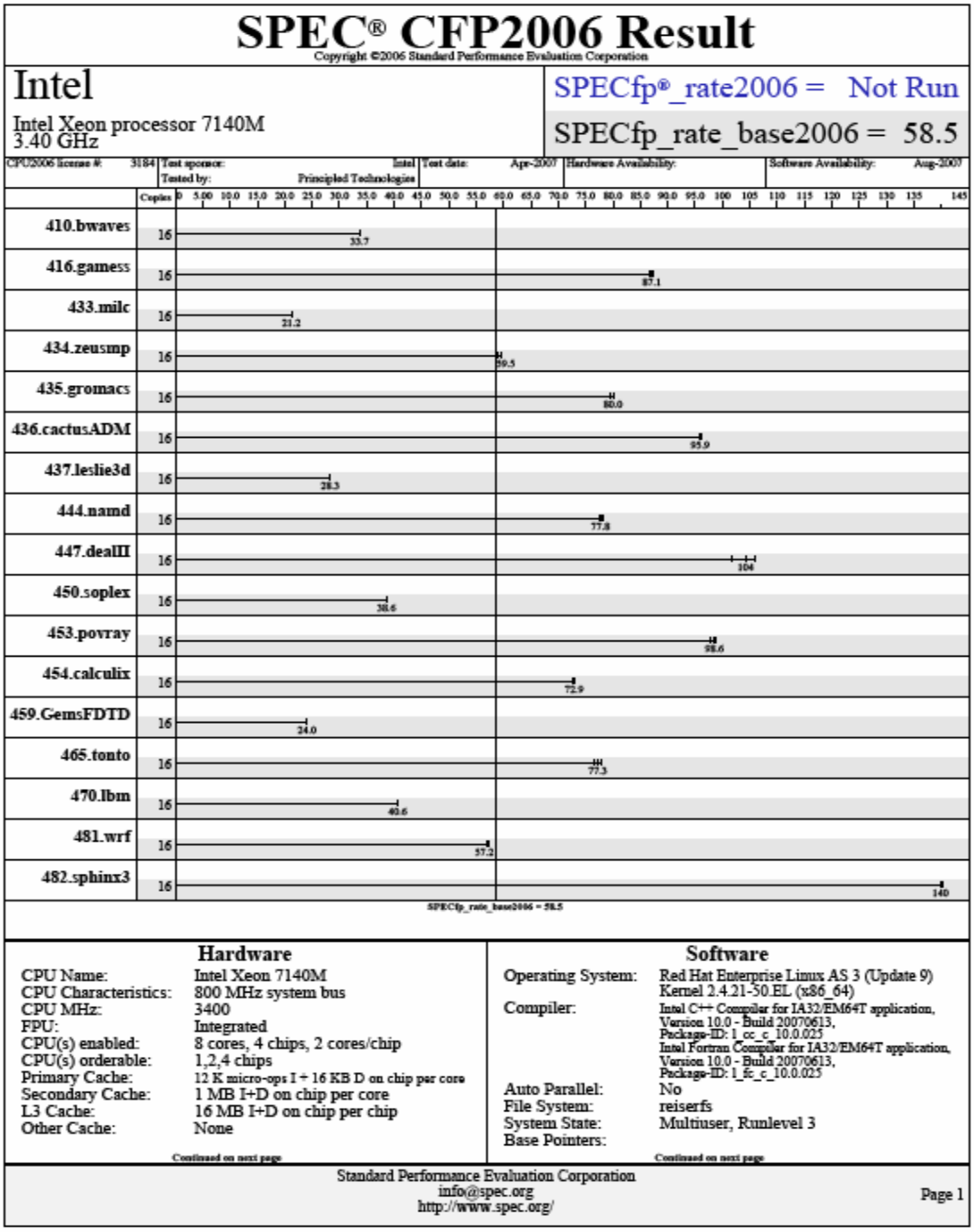
```
hw_avail           =
prepared_by        =
config             =

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_other000      = Smart Heap Library, Version 8.1
sw_base_ptrsize  = 32-bit
sw_peak_ptrsize  = 32/64-bit

fp=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_compiler003   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler004   = Version 10.0 - Build 20070613
sw_compiler005   = 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 – SPECfp_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® CFP2006 Result

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Intel

Intel Xeon processor 7140M
3.40 GHz

SPECfp®_rate2006 = Not Run

SPECfp_rate_base2006 = 58.5

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

	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 95.0 100 105 110 115 120 125 130 135 145
410.bwaves	16	33.7
416.gamess	16	87.1
433.milc	16	21.2
434.zeusmp	16	59.5
435.gromacs	16	80.0
436.cactusADM	16	95.9
437.leslie3d	16	28.3
444.namd	16	77.8
447.dealII	16	104
450.soplex	16	38.6
453.povray	16	98.6
454.calculix	16	72.9
459.GemsFDTD	16	24.0
465.tonto	16	77.3
470.lbm	16	40.6
481.wrf	16	57.2
482.sphinx3	16	140

SPECfp_rate_base2006 = 58.5

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
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

Continued on next page

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 Intel Fortran Compiler for IA32/EM64T application, Version 10.0 - Build 20070613, Package-ID: l_fc_c_10.0.025
Auto Parallel:	No
File System:	reiserfs
System State:	Multiuser, Runlevel 3
Base Pointers:	

Continued on next page

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http://www.spec.org/

Page 1

SPEC CFP2006 Result

Intel

Intel Xeon processor 7140M
3.40 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 58.5

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

Hardware (Continued)

Memory: 32 GB (16x2 GB DDR2 PC2-3200R)

Disk Subsystem: 1x146.8GB SCSI
Other Hardware: None

Software (Continued)

Peak Pointers:
Other Software: None

Results Table

Benchmark	Base							Peak						
	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	16	**6450**	**33.7**	6450	33.7	6440	33.7							
416.gamess	16	3610	86.8	**3600**	**87.1**	3590	87.3							
433.milc	16	**6920**	**21.2**	6920	21.2	6920	21.2							
434.zeusmp	16	2440	59.6	2460	59.1	**2450**	**59.5**							
435.gromacs	16	**1430**	**80.0**	1440	79.4	1430	80.0							
436.cactusADM	16	**1990**	**95.9**	1990	96.1	2000	95.7							
437.leslie3d	16	5310	28.3	**5310**	**28.3**	5320	28.3							
444.namd	16	1640	78.1	**1650**	**77.8**	1650	77.6							
447.dealII	16	1800	102	1730	106	**1760**	**104**							
450.soplex	16	3460	38.6	3450	38.6	**3460**	**38.6**							
453.povray	16	860	98.9	870	97.9	**864**	**98.6**							
454.calculix	16	**1810**	**72.9**	1820	72.7	1810	73.1							
459.GemsFDTD	16	**7060**	**24.0**	7060	24.0	7060	24.0							
465.tonto	16	2060	76.5	2020	77.9	**2040**	**77.3**							
470.lbm	16	**5410**	**40.6**	5410	40.7	5420	40.6							
481.wrf	16	3140	56.9	3120	57.2	**3130**	**57.2**							
482.sphinx3	16	2220	140	2230	140	**2230**	**140**							

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

SPEC CFP2006 Result

Intel

Intel Xeon processor 7140M
3.40 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 58.5

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

Base Compiler Invocation

C benchmarks:
icc

C++ benchmarks:
icpc

Fortran benchmarks:
ifort

Benchmarks using both Fortran and C:
ifort icc

Base Portability Flags

C benchmarks:
-DSPEC_CPU_LP64

C++ benchmarks (except as noted below):
-DSPEC_CPU_LP64

453.povray: -DSPEC_CPU_LP64

Fortran benchmarks:
-DSPEC_CPU_LP64

Benchmarks using both Fortran and C (except as noted below):
-DSPEC_CPU_LP64 -nofor_main

436.cactusADM: -DSPEC_CPU_LP64 -nofor_main

481.wrf: -DSPEC_CPU_LP64 -DSPEC_CPU_LINUX -DSPEC_CPU_CASE_FLAG

Base Optimization Flags

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

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

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

Benchmarks using both Fortran and C:
-O3 -no-prec-div -xP -ipo -static

SPEC CFP2006 Result

Intel

Intel Xeon processor 7140M
3.40 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 58.5

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

Base Other Flags

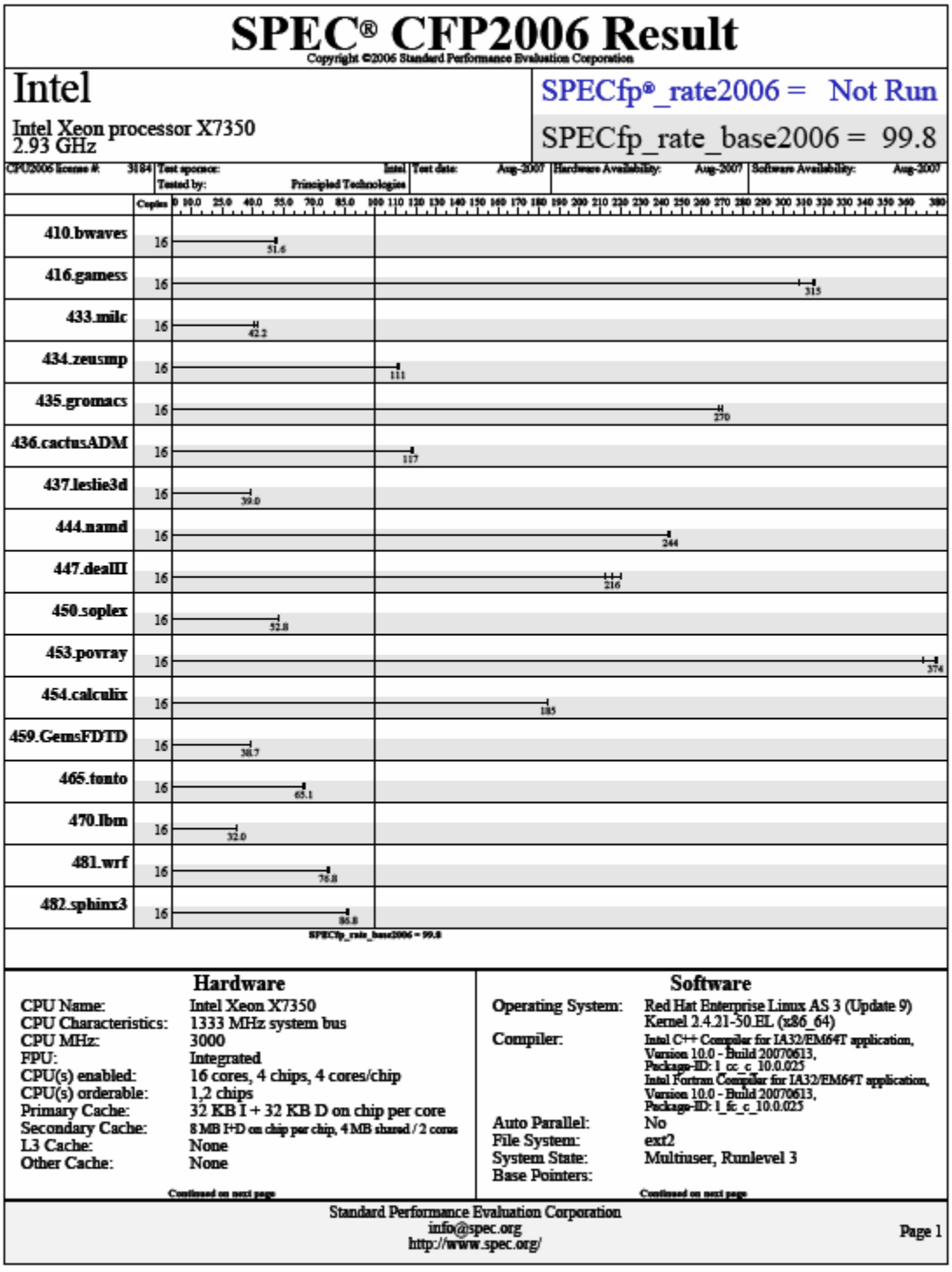
C benchmarks:
No flags used

C++ benchmarks:
No flags used

Fortran benchmarks:
No flags used

Benchmarks using both Fortran and C:
No flags used

Red Hat Enterprise Linux AS 3 guest on Red Hat Enterprise Linux 5.1 server on the Quad-Core Intel



SPEC CFP2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 99.8

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

Hardware (Continued)

Memory: 32 GB (16x2 GB DDR2 PC2-5300F)

Disk Subsystem: 1x73GB SAS
Other Hardware: None

Software (Continued)

Peak Pointers:
Other Software: None

Results Table

Benchmark	Base							Peak						
	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	16	4260	51.1	**4220**	**51.6**	4220	51.6							
416.gamess	16	1020	308	994	315	**996**	**315**							
433.milc	16	3600	40.8	**3480**	**42.2**	3470	42.3							
434.zeusmp	16	1310	111	1310	111	**1310**	**111**							
435.gromacs	16	425	269	**423**	**270**	423	270							
436.cactusADM	16	1630	117	**1630**	**117**	1610	118							
437.leslie3d	16	3890	38.7	3850	39.1	**3860**	**39.0**							
444.namd	16	528	243	525	245	**525**	**244**							
447.dealII	16	859	213	830	221	**847**	**216**							
450.soplex	16	2520	52.9	**2530**	**52.8**	2530	52.7							
453.povray	16	231	368	**227**	**374**	227	375							
454.calculix	16	715	185	**715**	**185**	717	184							
459.GemsFDTD	16	4380	38.7	**4390**	**38.7**	4390	38.6							
465.tonto	16	**2420**	**65.1**	2410	65.3	2440	64.5							
470.lbm	16	6870	32.0	**6870**	**32.0**	6880	32.0							
481.wrf	16	2340	76.5	**2330**	**76.8**	2320	77.1							
482.sphinx3	16	3640	85.7	3580	87.2	**3590**	**86.8**							

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

Continued on next page

SPEC CFP2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 99.8

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

Base Compiler Invocation (Continued)

C++ benchmarks:
icpc

Fortran benchmarks:
ifort

Benchmarks using both Fortran and C:
ifort icc

Base Portability Flags

C benchmarks:
-DSPEC_CPU_LP64

C++ benchmarks (except as noted below):
-DSPEC_CPU_LP64

453.povray: -DSPEC_CPU_LP64

Fortran benchmarks:
-DSPEC_CPU_LP64

Benchmarks using both Fortran and C (except as noted below):
-DSPEC_CPU_LP64 -nofor_main

436.cactusADM: -DSPEC_CPU_LP64 -nofor_main

481.wrf: -DSPEC_CPU_LP64 -DSPEC_CPU_LINUX -DSPEC_CPU_CASE_FLAG

Base Optimization Flags

C benchmarks:
-fast

C++ benchmarks:
-fast

Fortran benchmarks:
-fast

Benchmarks using both Fortran and C:
-fast

SPEC CFP2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 99.8

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

Base Other Flags

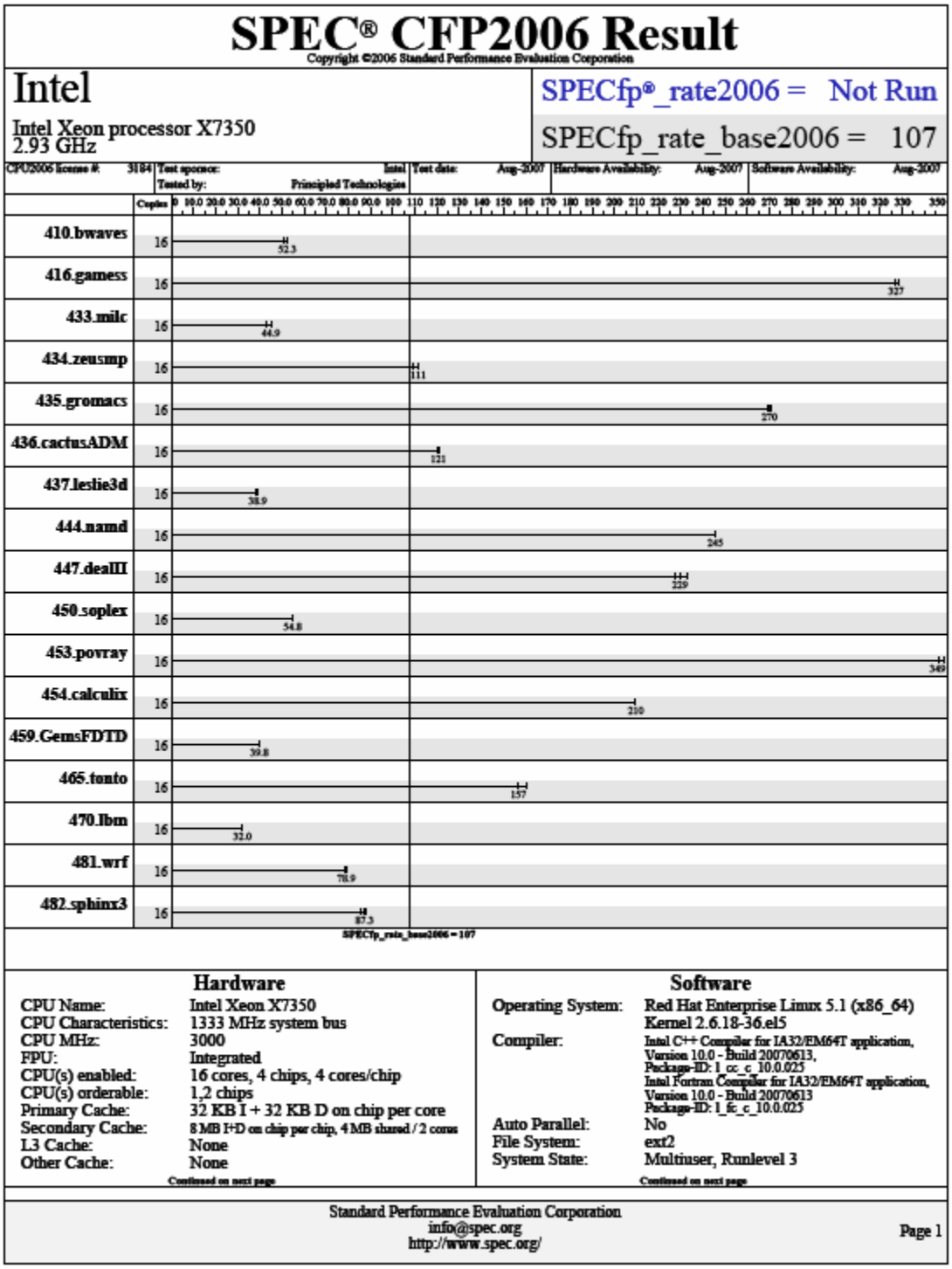
C benchmarks:
No flags used

C++ benchmarks:
No flags used

Fortran benchmarks:
No flags used

Benchmarks using both Fortran and C:
No flags used

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



SPEC CFP2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 107

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

Hardware (Continued)

Memory: 32 GB (16x2 GB DDR2 PC2-5300F)

Disk Subsystem: 1x73GB SAS
Other Hardware: None

Software (Continued)

Base Pointers:
Peak Pointers:
Other Software: None

Results Table

Benchmark	Base							Peak						
	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	16	4250	51.2	**4160**	**52.3**	4150	52.4							
416.gamess	16	955	328	958	327	**958**	**327**							
433.milc	16	3410	43.1	3270	44.9	**3270**	**44.9**							
434.zeusmp	16	1330	110	**1310**	**111**	1310	112							
435.gromacs	16	422	271	**423**	**270**	425	269							
436.cactusADM	16	1580	121	1590	120	**1580**	**121**							
437.leslie3d	16	3930	38.3	**3870**	**38.9**	3850	39.1							
444.namd	16	**523**	**245**	523	245	523	245							
447.dealII	16	786	233	805	227	**798**	**229**							
450.soplex	16	2440	54.6	**2440**	**54.8**	2440	54.8							
453.povray	16	244	349	**244**	**349**	246	347							
454.calculix	16	632	209	**630**	**210**	630	210							
459.GemsFDTD	16	4270	39.8	4260	39.9	**4260**	**39.8**							
465.tonto	16	983	160	**1000**	**157**	1010	157							
470.lbm	16	6910	31.8	**6870**	**32.0**	6870	32.0							
481.wrf	16	2270	78.6	2260	78.9	**2270**	**78.9**							
482.sphinx3	16	3640	85.7	**3570**	**87.3**	3560	87.6							

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

Continued on next page

SPEC CFP2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 107

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

Base Compiler Invocation (Continued)

C++ benchmarks:
icpc

Fortran benchmarks:
ifort

Benchmarks using both Fortran and C:
ifort icc

Base Portability Flags

C benchmarks:
-DSPEC_CPU_LP64

C++ benchmarks (except as noted below):
-DSPEC_CPU_LP64

453.povray: -DSPEC_CPU_LP64

Fortran benchmarks:
-DSPEC_CPU_LP64

Benchmarks using both Fortran and C (except as noted below):
-DSPEC_CPU_LP64 -nofor_main

436.cactusADM: -DSPEC_CPU_LP64 -nofor_main

481.wrf: -DSPEC_CPU_LP64 -DSPEC_CPU_LINUX -DSPEC_CPU_CASE_FLAG

Base Optimization Flags

C benchmarks:
-fast

C++ benchmarks:
-fast

Fortran benchmarks:
-fast

Benchmarks using both Fortran and C:
-fast

SPEC CFP2006 Result

Intel

Intel Xeon processor X7350
2.93 GHz

SPECfp_rate2006 = Not Run

SPECfp_rate_base2006 = 107

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

Base Other Flags

C benchmarks:
No flags used

C++ benchmarks:
No flags used

Fortran benchmarks:
No flags used

Benchmarks using both Fortran and C:
No flags used

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