SPEC CPU2006 SPECfp_rate power consumption on Dell, HP, and IBM servers

Executive summary

Dell Inc. (Dell) commissioned Principled Technologies (PT) to measure the SPEC CPU2006 SPECfp_rate2006 performance of the following four systems:

- Dell PowerEdge 2970 with two Dual-Core AMD Opteron 2222 SE processors
- Dell PowerEdge 2970 Energy Smart with two Dual-Core AMD Opteron 2212 HE processors
- HP ProLiant DL380 G5 with two Dual-Core Intel Xeon 5160 processors
- IBM System x3650 with two Dual-Core Intel Xeon 5160 processors

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

- The Dell PowerEdge 2970 Energy Smart delivered the highest performance per watt of the systems we tested during the SPECfp_rate2006 test (see Figure 1).

- The Dell PowerEdge 2970 and the Dell PowerEdge 2970 Energy Smart delivered 22.4 percent and 29.9 percent greater performance per watt, respectively, than the HP ProLiant DL380 G5 during the SPECfp_rate2006 test (see Figure 1).

- The Dell PowerEdge 2970 and the Dell PowerEdge 2970 Energy Smart delivered 12.9 percent and 19.8 percent greater performance per watt, respectively, than IBM System x3650 during the SPECfp_rate2006 test (see Figure 1).
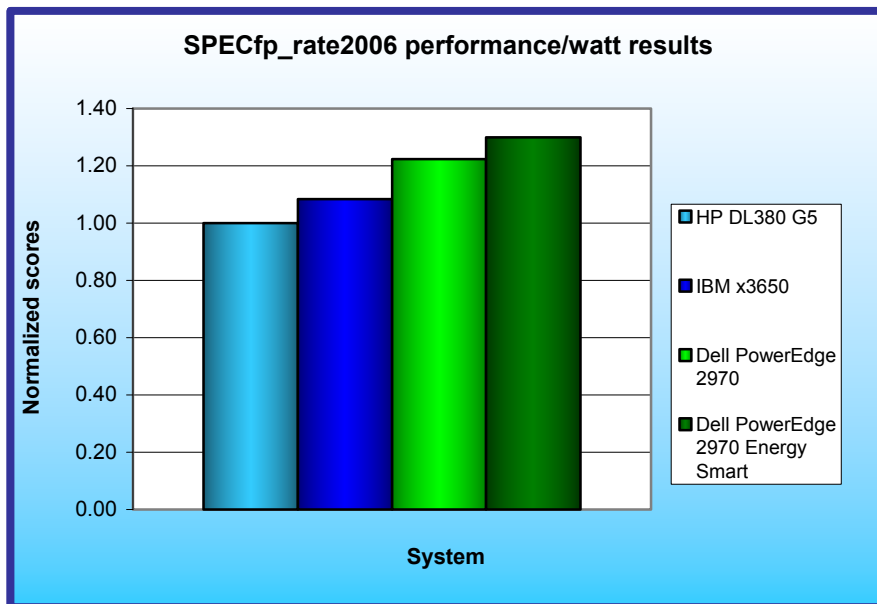
The SPEC CPU2006 benchmark consists of two benchmark suites, each of which focuses on a different aspect of compute-intensive performance. CINT2006 measures and compares compute-intensive integer performance, while CFP2006 measures and compares compute-intensive floating-point performance. A "rate" version of each, which runs multiple instances of the benchmark to assess server throughput, is also available. We ran only the CFP2006 SPECfp_rate benchmark.

Figure 1 illustrates the relative performance/watt for each of the four servers normalized to that of the poorest-performing server. Both the Dell PowerEdge 2970 and the Dell PowerEdge 2970 Energy Smart delivered greater performance per watt than the HP ProLiant DL380 G5 and the IBM System x3650. The Dell PowerEdge 2970 and the Dell PowerEdge 2970 Energy Smart delivered 22.4 percent and 29.9 percent greater performance per watt, respectively, than the HP ProLiant DL380 G5. The Dell PowerEdge 2970 and the Dell PowerEdge 2970 Energy Smart delivered 12.9 percent and 19.8 percent greater performance per watt, respectively, than the IBM System x3650.

Figure 1: Normalized performance/watt results of the test servers. Higher numbers are better.

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

$$\frac{\text{benchmark score}}{\text{average power consumption in watts during period of peak performance}}$$

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_rate2006 results for the test servers with four users.

Figure 2 lists the 17 applications that compose the CFP2006 benchmark. SPEC wrote six of the applications using Fortran, three using C, four using both Fortran and C, and four using 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.IBM	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 4 details the results of our tests with four users for SPECfp_rate2006. We determined the number of users based on the number of execution units in a given server. We used the same number of SPECfp_rate2006 users as processor execution units, so there is a one-to-one ratio.

SPECfp_rate2006 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.

Figure 3 details the power consumption, in watts, of the test servers while idle and during the benchmark. The idle power is an average of a two-minute power recording while the server was idle. The average power is an average power for the duration of the benchmark run.

Server	SPECfp_rate2006 results	SPECfp_base_rate2006 results	Idle power	Average power
Dell PowerEdge 2970	51.6	48.7	296.78	392.50
Dell PowerEdge 2970 Energy Smart	39.8	37.7	183.33	287.01
HP DL380 G5	42.6	41.3	302.00	396.50
IBM x3650	41.2	39.8	259.37	355.35

Figure 3: Power consumption, in watts, of the test servers while idle and during the benchmark.

Test methodology

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

Server	Dell PowerEdge 2970 with two Dual-Core AMD Opteron 2222 SE processors	Dell PowerEdge 2970 Energy Smart with two Dual-Core AMD Opteron 2212 HE processors	HP ProLiant DL380 G5 with two Dual-Core Intel Xeon 5160 processors	IBM System x3650 with two Dual-Core Intel Xeon 5160 processors
Processor frequency (GHz)	3.0 GHz	2.0 GHz	3.0 GHz	3.0 GHz
Front-side bus frequency (MHz)	1,000 MHz	1,000 MHz	1,333 MHz	1,333 MHz
Number of processor packages	2	2	2	2
Number of cores per processor package	2	2	2	2
Number of hardware threads per core	1	1	1	1
Motherboard	Dell CN-OFP973-69702-74H-0091	Dell CN-OFP973-69702-74H-0091	HP P3021ADMQUN203	IBM 7979AC1
Chipset	Broadcom HT-2100 and HT-1000 Chipset	Broadcom HT-2100 and HT-1000 Chipset	Intel 5000 Series Chipset	Intel 5000 Series Chipset
RAM (16 GB in each)	16 GB (8 x 2GB) PC2-5300 DDR2	16 GB (8 x 2GB) PC2-5300 DDR2	16 GB (8 x 2GB) PC2-5300 FBDIMM	16 GB (8 x 2GB) PC2-5300 FBDIMM
Hard drive	5 x 73GB Seagate ST973451SS	5 x 73GB Seagate ST973451SS	5 x 73GB Seagate ST973451SS	5 x 73GB Seagate ST973451SS

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

Dell configured and provided all of the systems.

With the exception of disabling the Hardware Prefetcher and Adjacent Sector Prefetcher settings on the Intel-based servers, we used the default BIOS settings on each server. We changed those two settings to match those on similar systems with published SPEC CPU2006 results.

For all systems we used the default power settings, which were the following:

- Dell PowerEdge 2970—Demand-Based Power Management (PowerNow) disabled

- Dell PowerEdge 2970 Energy Smart—Demand-Based Power Management (PowerNow) enabled
- HP ProLiant DL380 G5—HP Dynamic Power Savings Mode enabled
- IBM System x3650—PowerExecutive Power Capping enabled

Changing those settings would have resulted in different power usage characteristics.

We began by installing a fresh copy of SuSE Linux Enterprise Server 10 SP1. We made no additional changes to the default installation options.

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:

- HP ProLiant DL380 G5 and IBM System x3650
    - Intel C/C++ Compiler 9.1.051 for EM64T
    - Intel Fortran Compiler 9.1.051 for EM64T
- Dell PowerEdge 2970 and Dell PowerEdge 2970 Energy Smart
    - PathScale 3.0 C Compiler
    - PathScale 3.0 C++ Compiler
    - PathScale 3.0 Fortran Compiler

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.

To begin the benchmark, we performed the following steps:

- Open a command prompt.
- Change to the cpu2006 directory.
- Type ". ./shrc" at the command prompt.
- Type "ulimit -s unlimited" at the command prompt.
- Enter "runspec -c <config file name> -r 4 -T all -v 10 fp" where
    - <config file name> = name of the configuration file

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.

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 3.0) 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 for two minutes 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 Figure 4 (idle and average peak power) for the results of these measurements.

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.

Systems	Dell PowerEdge 2970 with two Dual-Core AMD Opteron 2222 SE processors	Dell PowerEdge 2970 Energy Smart with two Dual-Core AMD Opteron 2212 HE processors	HP ProLiant DL380 G5 with two Dual-Core Intel Xeon 5160 processors	IBM System x3650 with two Dual-Core Intel Xeon 5160 processors
General processor setup				
Number of processor packages	2	2	2	2
Number of cores per processor package	2	2	2	2
Number of hardware threads per core	1	1	1	1
CPU				
Vendor	AMD	AMD	Intel	Intel
Name	Opteron 2222 SE	Opteron 2212 HE	Xeon 5160	Xeon 5160
Stepping	F2	F2	B2	B2
Socket type	Socket F	Socket F	LGA771	LGA771
Core frequency (GHz)	3.0 GHz	2.0 GHz	3.0 GHz	3.0 GHz
Front-side bus frequency (MHz)	1,000 MHz HyperTransport technology	1,000 MHz HyperTransport technology	1,333 MHz	1,333 MHz
L1 cache	64 KB + 64 KB (per core)	64 KB + 64 KB (per core)	32 KB + 32KB (per core)	32 KB + 32KB (per core)
L2 cache	2 x 1 MB	2 x 1 MB	4 MB (shared)	4 MB (shared)
Platform				
Vendor and model number	Dual-Core AMD Opteron processor model 2222 SE-based server	Dual-Core AMD Opteron processor model 2212 HE-based server	Dual-Core Intel Xeon processor model 5160-based server	Dual-Core Intel Xeon processor model 5160-based server
Motherboard model number	Dell CN-OFP973-69702-74H-0091	Dell CN-OFP973-69702-74H-0091	HP P3021ADMQUN203	IBM 7979AC1
Motherboard chipset	Broadcom HT-2100 and HT-1000 Chipset	Broadcom HT-2100 and HT-1000 Chipset	Intel 5000 Series Chipset	Intel 5000 Series Chipset
Motherboard serial number	F3G57D1	F3G57D1	013096-001	KQHRHY0
BIOS name and version	Dell BIOS 1.0.0	Dell BIOS 1.0.0	HP BIOS P56	IBM BIOS 1.05
BIOS settings	Default	Default	Default	Default
Power settings (default)	Demand-Based Power Management (PowerNow) disabled	Demand-Based Power Management (PowerNow) enabled	HP Dynamic Power Savings Mode enabled	PowerExecutive Power Capping enabled

Systems	Dell PowerEdge 2970 with two Dual-Core AMD Opteron 2222 SE processors	Dell PowerEdge 2970 Energy Smart with two Dual-Core AMD Opteron 2212 HE processors	HP ProLiant DL380 G5 with two Dual-Core Intel Xeon 5160 processors	IBM System x3650 with two Dual-Core Intel Xeon 5160 processors
Memory module(s)				
Vendor and model number	Infineon HYS72T256220HP-3S-A	Infineon HYS72T256220HP-3S-A	Kingston KTH-XW667/4G	Kingston KTM5780/4G
Type	PC2-5300 DDR2	PC2-5300 DDR2	PC2-5300 FBDIMM	PC2-5300 FBDIMM
Speed (MHz)	667 MHz	667 MHz	667 MHz	667 MHz
Speed in the system currently running @ (MHz)	333 MHz	333 MHz	333 MHz	333 MHz
Timing/Latency (tCL-tRCD-iRP-tRASmin)	5-5-5-12	5-5-5-12	5-5-5-10	5-5-5-11
Size	16 GB	16 GB	16 GB	16 GB
Number of RAM modules	8 x 2,048 MB	8 x 2,048 MB	8 x 2,048 MB	8 x 2,048 MB
Chip organization	Double-sided	Double-sided	Double-sided	Double-sided
Hard disk				
Vendor and model number	Seagate ST973451SS	Seagate ST973451SS	Seagate ST973451SS	Seagate ST973451SS
Number of disks in system	5	5	5	5
Size	73 GB	73 GB	73 GB	73 GB
Buffer size	16 MB	16 MB	16 MB	16 MB
RPM	15,000	15,000	15,000	15,000
Type	SAS	SAS	SAS	SAS
Controller	PERC 5i	PERC 5i	Smart Array P400	IBM ServeRAID 8K
Remote management	Dell Remote Access Controller – N/A	Dell Remote Access Controller – N/A	iLO2 Standard Management – N/A	N/A
Power supplies				
Total number	2	2	2	1
Wattage of each	750	750	900	835

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

Appendix B – SPECfp_rate2006 configuration files

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

AMD processor based servers

```
######################################################################
# AMD64 (64-bit) Linux Pathscale v3.0 config file
#  for CPU2006
####################################################################

flagsurl=http://www.spec.org/cpu2006/flags/CPU2006_flags.20070501.xml
tune          = base
ext           = amd514K8
output_format = asc,html
teeout        = yes
teerunout     = yes
mean_anyway   = yes
reportable    = yes
sw_avail       = Sep-2007

submit                    = taskset -c $SPECCOPYNUM $command

sw_compiler000 = QLogic PathScale
sw_compiler001 = Compiler Suite, Release 3.0
sw_other000    = SmartHeap 8.1 32 bit Library for Linux
sw_auto_parallel   = No

####################################################################
# Macro section
####################################################################
# Modify this section to use the appropriate architecture flags.
# Leave these commented out if you are defining them from the
#  runspec command.

%define gnu4_fe
# %define gnu3_fe


default=default=default:
####################################################################
# Compiler selection
#
#
CC            = pathcc
CXX           = pathCC
FC            = pathf95
SMARTHEAP_DIR = /cpu2006/mpaton/1.0/amd514K8.lib/32


####################################################################
# Portability for default 64-bit code generation
####################################################################

default=default=default:
PORTABILITY = -DSPEC_CPU_LP64

####################################################################
# INT Portability
####################################################################

400.perlbench=default=default:
CPORTABILITY = -DSPEC_CPU_LINUX_X64 -DSPEC_CPU_LP64

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

471.omnetpp=default=default:
# Needed to avoid -DSPEC_CPU_LP64 on -m32 C++ base codes
```

```
PORTABILITY =

473.astar=default=default:
# Needed to avoid -DSPEC_CPU_LP64 on -m32 C++ base codes
PORTABILITY =

483.xalancbmk=default=default:
CXXPORTABILITY= -DSPEC_CPU_LINUX
# Needed to avoid -DSPEC_CPU_LP64 on -m32 C++ base codes
PORTABILITY =

####################################################################
#                                                                  #
#          SPECint Tuning & Notes                                  #
#                                                                  #
####################################################################

int=base:
COPTIMIZE    = -Ofast -OPT:malloc_alg=1
CXXOPTIMIZE  = -Ofast -m32
EXTRA_CXXLIBS= -L$(SMARTHEAP_DIR) -lsmartheap

sw_base_ptrsize  = 32/64-bit
sw_peak_ptrsize  = 32/64-bit

####################################################################
# INT Peak Tuning
####################################################################

int=peak=default:
COPTIMIZE    = -Ofast -OPT:malloc_alg=1
CXXOPTIMIZE  = -Ofast -m32
EXTRA_CXXLIBS= -L$(SMARTHEAP_DIR) -lsmartheap
PASS1_CFLAGS   = -fb_create fbdata
PASS1_CXXFLAGS  = -fb_create fbdata
PASS1_LDFLAGS  = -fb_create fbdata
PASS2_CFLAGS   = -fb_opt fbdata
PASS2_CXXFLAGS  = -fb_opt fbdata
PASS2_LDFLAGS  = -fb_opt fbdata

400.perlbench=peak=default:
COPTIMIZE=-Ofast -LNO:opt=0

401.bzip2=peak=default:
COPTIMIZE=-O3 -LNO:ou_prod_max=10 -OPT:Ofast:alias=disjoint
feedback=0

403.gcc=peak=default:
PORTABILITY =
COPTIMIZE=-m32 -O3 -OPT:Ofast

429.mcf=peak=default:
PORTABILITY =
COPTIMIZE=-m32 -O3 -ipa
feedback=0
EXTRA_CLIBS = -L$(SMARTHEAP_DIR) -lsmartheap

445.gobmk=peak=default:
COPTIMIZE=-O3 -OPT:alias=disjoint -LNO:simd=0:minvariant=off -WOPT:retype_expr=on

456.hmmer=peak=default:
COPTIMIZE=-O2 -OPT:alias=disjoint:malloc_alg=1 -CG:cflow=0
feedback=0

458.sjeng=peak=default:
COPTIMIZE=-O3 -IPA:plimit=50000 -IPA:pu_reorder=2

462.libquantum=peak=default:
COPTIMIZE=-O3 -ipa -CG:local_fwd_sched=on -IPA:space=1000
feedback=0
```

```
464.h264ref=peak=default:
COPTIMIZE=-O3 -IPA:plimit=20000 -OPT:alias=disjoint -LNO:prefetch=0

471.omnetpp=peak=default:
CXXOPTIMIZE= -Ofast -CG:gcm=off -m32
feedback=0

473.astar=peak=default:
basepeak=true

483.xalancbmk=peak=default:
CXXOPTIMIZE=-Ofast -m32 -OPT:unroll_times_max=8
feedback=0

#####################################################################
# FP Portability
#####################################################################

436.cactusADM=default=default:
FPORTABILITY=  -fno-second-underscore

%ifdef %{gnu4_fe}
447.dealII=default=default:
CXXPORTABILITY =
%else
447.dealII=default=default:
CXXPORTABILITY = -DSPEC_CPU_TABLE_WORKAROUND
%endif

481.wrf=default=default:
FPORTABILITY= -fno-second-underscore
CPORTABILITY= -DSPEC_CPU_LINUX

#################################################################
#                                                               #
#                       SPECfp Tuning                           #
#                                                               #
#################################################################

fp=base:
COPTIMIZE    = -Ofast
CXXOPTIMIZE  = -Ofast
FOPTIMIZE    = -Ofast -OPT:malloc_alg=1

sw_base_ptrsize  = 64-bit
sw_peak_ptrsize  = 32/64-bit
sw_other001= None

#####################################################################
# FP Peak Tuning
#####################################################################

fp=peak=default:
COPTIMIZE    = -Ofast
CXXOPTIMIZE  = -Ofast
FOPTIMIZE    = -Ofast -OPT:malloc_alg=1
PASS1_CFLAGS   = -fb_create fbdata
PASS2_CFLAGS   = -fb_opt fbdata
PASS1_CXXFLAGS = -fb_create fbdata
PASS2_CXXFLAGS = -fb_opt fbdata
PASS1_FFLAGS   = -fb_create fbdata
PASS2_FFLAGS   = -fb_opt fbdata
PASS1_LDFLAGS  = -fb_create fbdata
PASS2_LDFLAGS  = -fb_opt fbdata

410.bwaves=peak=default:
FOPTIMIZE=-O3 -OPT:Ofast:IEEE_arith=3 -LNO:blocking=off:ignore_feedback=off

416.gamess=peak=default:
```

```
FOPTIMIZE=-O2 -OPT:Ofast:ro=3:unroll_size=256


433.milc=peak=default:
COPTIMIZE=-Ofast -CG:cflow=off -LNO:prefetch=1 -OPT:malloc_alg=1
feedback=0


434.zeusmp=peak=default:
FOPTIMIZE=-Ofast -CG:local_fwd_sched=on -LNO:blocking=off:interchange=off:fu=10:full_unroll_outer=on
feedback=0


435.gromacs=peak=default:
FOPTIMIZE=-O3 -OPT:rsqrt=2:ro=3
COPTIMIZE=-O3 -OPT:rsqrt=2:ro=3
feedback=0


436.cactusADM=peak=default:
COPTIMIZE=-O3 -LNO:prefetch=3:prefetch_ahead=5:ou_prod_max=10:full_unroll=5 -ipa
FOPTIMIZE=-O3 -LNO:prefetch=3:prefetch_ahead=5:ou_prod_max=10:full_unroll=5 -ipa


437.leslie3d=peak=default:
basepeak=true


444.namd=peak=default:
CXXOPTIMIZE=-Ofast -fno-exceptions


447.dealII=peak=default:
# Needed to avoid -DSPEC_CPU_LP64
PORTABILITY =
%ifdef %{gnu4_fe}
CXXOPTIMIZE=-Ofast -static -INLINE:aggressive=on -OPT:malloc_alg=1 -m32 -fno-exceptions
feedback=0
%else
CXXOPTIMIZE=-Ofast -INLINE:aggressive=on -LNO:opt=0 -OPT:alias=disjoint -m32 -fno-exceptions
feedback=0
%endif


450.soplex=peak=default:
CXXOPTIMIZE=-m32 -O3 -OPT:IEEE_arith=3 -CG:load_exe=0:movnti=1 -LNO:minvariant=off:prefetch=1 -fno-
exceptions
# Needed to avoid -DSPEC_CPU_LP64
PORTABILITY =


453.povray=peak=default:
CXXOPTIMIZE=-Ofast -fno-fast-math


454.calculix=peak=default:
FOPTIMIZE=-Ofast -LNO:simd=0 -WOPT:mem_opnds=on
COPTIMIZE=$(FOPTIMIZE)
feedback=0


459.GemsFDTD=peak=default:
FOPTIMIZE=-Ofast -LNO:fission=2:prefetch=0
feedback=0


465.tonto=peak=default:
basepeak=true


470.lbm=peak=default:
basepeak=true


481.wrf=peak=default:
basepeak=true


482.sphinx3=peak=default:
%ifdef %{gnu4_fe}
COPTIMIZE=-O3 -OPT:Ofast -WOPT:aggstr=0 -m32
%else
basepeak=true
%endif
```

Intel processor based servers

```
#######################################################
# SPEC CPU2006 Intel SLES10 x64 (64-bit) config file #
# Intel Compiler 9.1 for Linux Intel64               #
#######################################################

action     = validate
tune       = base or peak
ext        = cpu2006.1.0.SLES10x64.ic91.em64t
PATHSEP    = /
flagsurl   = CPU2006_flags.20070417.xml

check_md5   = 1
mean_anyway = 1
reportable  = 1

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

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= -fast
CXXOPTIMIZE= -xP -O3 -ipo -no-prec-div
EXTRA_CXXLIBS= -L$(SMARTHEAP_DIR) -lsmartheap

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

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

```
######################

int=peak=default=default:
OPTIMIZE= -fast
EXTRA_LIBS= -L$(SMARTHEAP_DIR) -lsmartheap

PASS1_CFLAGS   = -prof_gen
PASS2_CFLAGS   = -prof_use
PASS1_CXXFLAGS = -prof_gen
PASS2_CXXFLAGS = -prof_use
PASS1_LDFLAGS  = -prof_gen
PASS2_LDFLAGS  = -prof_use

fp=peak=default=default:
OPTIMIZE= -fast

PASS1_CFLAGS   = -prof_gen
PASS2_CFLAGS   = -prof_use
PASS1_FFLAGS   = -prof_gen
PASS2_FFLAGS   = -prof_use
PASS1_CXXFLAGS = -prof_gen
PASS2_CXXFLAGS = -prof_use
PASS1_LDFLAGS  = -prof_gen
PASS2_LDFLAGS  = -prof_use

400.perlbench=peak=default=default:
EXTRA_LIBS=

401.bzip2=peak=default=default:
CC=/opt/intel/cce/9.1.051/bin/icc -I/opt/intel/cce/9.1.051/include -L/opt/intel/cce/9.1.051/lib
PORTABILITY=-DSPEC_CPU_LP64
EXTRA_LIBS=
feedback=0

403.gcc=peak=default=default:
basepeak=yes

456.hmmer=peak=default=default:
CC=/opt/intel/cce/9.1.051/bin/icc -I/opt/intel/cce/9.1.051/include -L/opt/intel/cce/9.1.051/lib
PORTABILITY=-DSPEC_CPU_LP64
EXTRA_LIBS=

462.libquantum=peak=default=default:
CC=/opt/intel/cce/9.1.051/bin/icc -I/opt/intel/cce/9.1.051/include -L/opt/intel/cce/9.1.051/lib
PORTABILITY=-DSPEC_CPU_LP64
EXTRA_LIBS=

471.omnetpp=peak=default=default:
OPTIMIZE=-xP -O3 -ipo -no-prec-div

483.xalancbmk=peak=default=default:
basepeak=yes

410.bwaves=peak=default=default:
basepeak=yes

416.gamess=peak=default=default:
basepeak=yes

433.milc=peak=default=default:
PORTABILITY=
CC=/opt/intel/cc/9.1.051/bin/icc -I/opt/intel/cc/9.1.051/include -L/opt/intel/cc/9.1.051/lib

434.zeusmp=peak=default=default:
PORTABILITY=
FC=/opt/intel/fc/9.1.051/bin/ifort -I/opt/intel/fc/9.1.051/include -L/opt/intel/fc/9.1.051/lib
feedback=0

436.cactusADM=peak=default=default:
basepeak=yes
```

```
437.leslie3d=peak=default=default:
basepeak=yes

444.namd=peak=default=default:
basepeak=yes

450.soplex=peak=default=default:
PORTABILITY=
CXX=/opt/intel/cc/9.1.051/bin/icpc -I/opt/intel/cc/9.1.051/include -L/opt/intel/cc/9.1.051/lib

459.GemsFDTD=peak=default=default:
basepeak=yes

470.lbm=peak=default=default:
PORTABILITY=
CC=/opt/intel/cc/9.1.051/bin/icc -I/opt/intel/cc/9.1.051/include -L/opt/intel/cc/9.1.051/lib

481.wrf=peak=default=default:
basepeak=yes

482.sphinx3=peak=default=default:
PORTABILITY=
CC=/opt/intel/cc/9.1.051/bin/icc -I/opt/intel/cc/9.1.051/include -L/opt/intel/cc/9.1.051/lib
feedback=0

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

int=default=default=default:
sw_compiler001   = Intel C++ Compiler for IA32/EM64T application,
sw_compiler002   = Version 9.1 - Build 20070215, Package-ID: l_cc_p_9.1.051
sw_other         = 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 9.1 - Build 20070215, Package-ID:
sw_compiler002   = l_cc_p_9.1.051
sw_compiler003   = Intel Fortran Compiler for IA32/EM64T application,
sw_compiler004   = Version 9.1 - Build 20070215, Package ID:
sw_compiler005   = l_fc_p_9.1.051
sw_other000      = SmartHeap 8.1 32 bit Library for Linux
sw_other001      = None
sw_base_ptrsize  = 64-bit
sw_peak_ptrsize  = 32/64-bit

default=default=default=default:
sw_os            = SuSE Linux Enterprise Server 10 SP1 64-bit kernel
sw_avail         = Sep-2007
sw_auto_parallel = No
```

Appendix C – SPECfp_rate2006 output

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

Dell PowerEdge 2970 with two Dual-Core AMD Opteron 2222 SE processors

SPEC® CFP2006 Result

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Dell Inc.

PowerEdge 2970
AMD Opteron 2222 SE, 3.0 GHz

SPECfp®_rate2006 = 51.6

SPECfp_rate_base2006 = 48.7

CPU2006 license #: 3184 Test sponsor: Dell Inc. Test date: Sep-2007 Hardware Availability: Sep-2007 Software Availability: Sep-2007
Tested by: Principled Technologies

Benchmark	base	peak
410.bwaves	63.5	64.3
416.gamess	60.1	68.4
433.milc	38.3	38.1
434.zeusmp	46.8	47.0
435.gromacs	53.4	60.7
436.cactusADM	48.2	50.1
437.leslie3d	39.2	
444.namd	52.1	55.2
447.dealII	74.8	96.0
450.soplex	34.7	39.3
453.povray	69.3	76.6
454.calculix	31.7	34.2
459.GemsFDTD	34.5	35.3
465.tonto	61.1	
470.lbm	36.7	
481.wrf	57.2	
482.sphinx3	53.6	55.2

SPECfp_rate_base2006 = 48.7
SPECfp_rate2006 = 51.6

Hardware		Software	
CPU Name:	AMD Opteron 2222 SE	Operating System:	SuSE Linux Enterprise Server 10 SP1 64-bit kernel
CPU Characteristics:	1000 MHz HyperTransport technology	Compiler:	QLogic PathScale
CPU MHz:	3000		Compiler Suite, Release 3.0
FPU:	Integrated	Auto Parallel:	No
CPU(s) enabled:	4 cores, 2 chips, 2 cores/chip	File System:	Linux/reiserfs
CPU(s) orderable:	1,2 chips	System State:	Multi-user, run level 3
Primary Cache:	64 KB I + 64 KB D on chip per core	Base Pointers:	64-bit
Secondary Cache:	1 MB I+D on chip per core	Peak Pointers:	32/64-bit
L3 Cache:	None	Other Software:	SmartHeap 8.1 32 bit Library for Linux
Other Cache:	None		None

Continued on next page

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Page 1

SPEC CFP2006 Result

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Dell Inc.

PowerEdge 2970
AMD Opteron 2222 SE, 3.0 GHz

SPECfp_rate2006 =	51.6
SPECfp_rate_base2006 =	48.7

CPU2006 license #:	3184	Test sponsor:		Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies							

Hardware (Continued)

Memory:	16 GB (8x2 GB DDR2 PC2-5300)
Disk Subsystem:	SAS, 73 GB
Other Hardware:	None

Results Table

Benchmark	Copies	Base Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Peak Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	4	854	63.7	**857**	**63.5**	862	63.0	4	**846**	**64.3**	846	64.2	846	64.3
416.gamess	4	1300	60.2	1310	59.9	**1300**	**60.1**	4	1140	68.5	**1150**	**68.4**	1150	68.3
433.milc	4	960	38.2	**960**	**38.3**	958	38.3	4	967	38.0	960	38.2	**963**	**38.1**
434.zeusmp	4	775	47.0	**778**	**46.8**	781	46.6	4	775	47.0	771	47.2	**774**	**47.0**
435.gromacs	4	**534**	**53.4**	535	53.4	534	53.5	4	471	60.6	**471**	**60.7**	470	60.8
436.cactusADM	4	995	48.1	**991**	**48.2**	951	50.3	4	963	49.6	**954**	**50.1**	918	52.1
437.leslie3d	4	**959**	**39.2**	958	39.3	968	38.9	4	**959**	**39.2**	958	39.3	968	38.9
444.namd	4	**616**	**52.1**	616	52.0	616	52.1	4	**581**	**55.2**	581	55.2	581	55.2
447.dealII	4	611	74.9	**611**	**74.8**	618	74.1	4	477	95.9	**476**	**96.0**	476	96.0
450.soplex	4	**961**	**34.7**	964	34.6	960	34.8	4	849	39.3	848	39.3	**848**	**39.3**
453.povray	4	**307**	**69.3**	307	69.4	308	69.2	4	278	76.7	278	76.6	**278**	**76.6**
454.calculix	4	1040	31.7	**1040**	**31.7**	1040	31.7	4	**965**	**34.2**	964	34.2	965	34.2
459.GemsFDTD	4	**1230**	**34.5**	1220	34.7	1230	34.5	4	1200	35.2	**1200**	**35.3**	1180	35.9
465.tonto	4	643	61.2	**644**	**61.1**	648	60.8	4	643	61.2	**644**	**61.1**	648	60.8
470.lbm	4	1490	36.8	1500	36.7	**1500**	**36.7**	4	1490	36.8	1500	36.7	**1500**	**36.7**
481.wrf	4	778	57.4	**781**	**57.2**	789	56.7	4	778	57.4	**781**	**57.2**	789	56.7
482.sphinx3	4	**1450**	**53.6**	1460	53.6	1450	53.6	4	**1410**	**55.2**	1420	55.0	1410	55.4

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

Compiler Invocation

C benchmarks:
    pathcc

C++ benchmarks:
    pathCC

Fortran benchmarks:
    pathf95

Benchmarks using both Fortran and C:
    pathcc pathf95

SPEC CFP2006 Result

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Dell Inc.

PowerEdge 2970
AMD Opteron 2222 SE, 3.0 GHz

SPECfp_rate2006 =	51.6
SPECfp_rate_base2006 =	48.7

CPU2006 license #:	3184	Test sponsor:	Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

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

    436.cactusADM: -DSPEC_CPU_LP64 -fno-second-underscore

        481.wrf: -DSPEC_CPU_LP64 -DSPEC_CPU_LINUX -fno-second-underscore

Peak Portability Flags

C benchmarks (except as noted below):
    -DSPEC_CPU_LP64

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

        444.namd: -DSPEC_CPU_LP64

        453.povray: -DSPEC_CPU_LP64

Fortran benchmarks (except as noted below):
    -DSPEC_CPU_LP64

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

    436.cactusADM: -DSPEC_CPU_LP64 -fno-second-underscore

Base Optimization Flags

C benchmarks:
    -Ofast

C++ benchmarks:
    -Ofast

Fortran benchmarks:
    -Ofast -OPT:malloc_alg=1

SPEC CFP2006 Result

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Dell Inc.

PowerEdge 2970
AMD Opteron 2222 SE, 3.0 GHz

SPECfp_rate2006 =	51.6
SPECfp_rate_base2006 =	48.7

CPU2006 license #:	3184	Test sponsor:		Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies							

Base Optimization Flags (Continued)

Benchmarks using both Fortran and C:
```
-Ofast -OPT:malloc_alg-1
```

Peak Optimization Flags

C benchmarks:

433.milc: `-Ofast -CG:cflow-off -LNO:prefetch-1 -OPT:malloc_alg-1`

470.lbm: `basepeak - yes`

482.sphinx3: `-O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -m32 -OPT:Ofast -WOPT:aggstr-0`

C++ benchmarks:

444.namd: `-Ofast -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -fno-exceptions`

447.dealII: `-Ofast -fno-exceptions -INLINE:aggressive-on -m32 -OPT:malloc_alg-1`

450.soplex: `-O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -fno-exceptions -CG:load_exe-0 -CG:movnti-1 -LNO:minvariant-off -LNO:prefetch-1 -m32 -OPT:IEEE_arith-3`

453.povray: `-Ofast -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -fno-fast-math`

Fortran benchmarks (except as noted below):
```
basepeak - yes
```

410.bwaves: `-O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -LNO:blocking-off -LNO:ignore_feedback-off -OPT:IEEE_arith-3 -OPT:Ofast`

416.gamess: `-O2 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -OPT:Ofast -OPT:ro-3 -OPT:unroll_size-256`

434.zeusmp: `-Ofast -CG:local_fwd_sched-on -LNO:blocking-off -LNO:fu-10 -LNO:full_unroll_outer-on -LNO:interchange-off`

459.GemsFDTD: `-Ofast -LNO:fission-2 -LNO:prefetch-0`

Benchmarks using both Fortran and C:

435.gromacs: `-O3 -OPT:ro-3 -OPT:rsqrt-2`

436.cactusADM: `-O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -ipa -LNO:full_unroll-5 -LNO:ou_prod_max-10 -LNO:prefetch_ahead-5 -LNO:prefetch-3`

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PowerEdge 2970
AMD Opteron 2222 SE, 3.0 GHz

SPECfp_rate2006 =	51.6
SPECfp_rate_base2006 =	48.7

CPU2006 license #:	3184	Test sponsor:	Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Peak Optimization Flags (Continued)

454.calculix: -Ofast -LNO:simd-0 -WOPT:mem_opnds-on

481.wrf: basepeak - yes

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

Peak Other Flags

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

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

447.dealII: -static

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

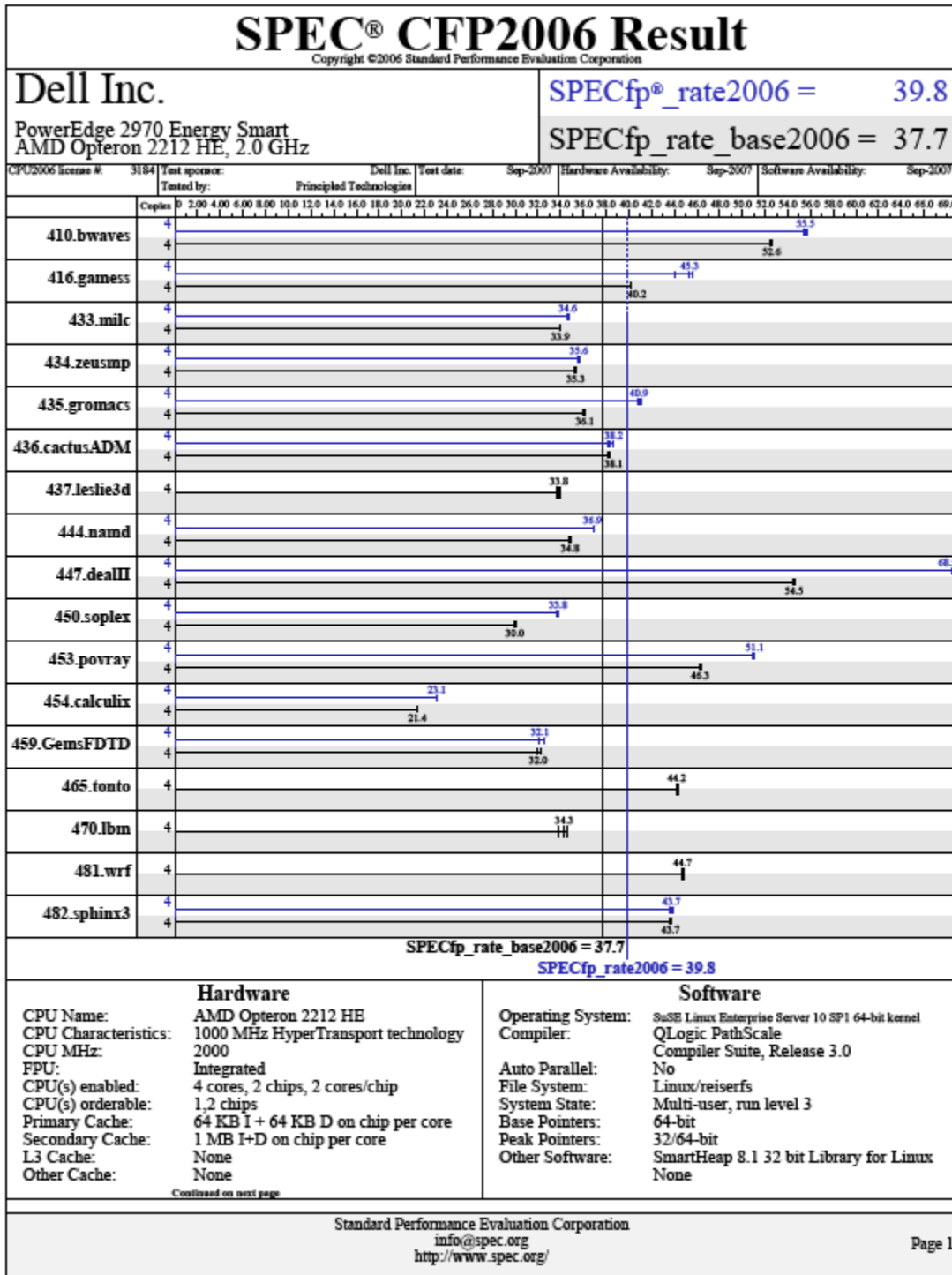Benchmarks using both Fortran and C (except as noted below):
      No flags used

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Page 5

Dell PowerEdge 2970 Energy Smart with two Dual-Core AMD Opteron 2212 HE processors

SPEC® CFP2006 Result
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Dell Inc.

PowerEdge 2970 Energy Smart
AMD Opteron 2212 HE, 2.0 GHz

SPECfp®_rate2006 = 39.8

SPECfp_rate_base2006 = 37.7

CPU2006 license #:	3184	Test sponsor:	Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Results by benchmark (Copies = 4):

Benchmark	Base	Peak
410.bwaves	52.6	55.5
416.gamess	40.2	45.3
433.milc	33.9	34.6
434.zeusmp	35.3	35.6
435.gromacs	36.1	40.9
436.cactusADM	38.1	38.2
437.leslie3d	33.8	
444.namd	34.8	36.9
447.dealII	54.5	68.5
450.soplex	30.0	33.8
453.povray	46.3	51.1
454.calculix	21.4	23.1
459.GemsFDTD	32.0	32.1
465.tonto	44.2	
470.lbm	34.3	
481.wrf	44.7	
482.sphinx3	43.7	43.7

SPECfp_rate_base2006 = 37.7

SPECfp_rate2006 = 39.8

Hardware		Software	
CPU Name:	AMD Opteron 2212 HE	Operating System:	SuSE Linux Enterprise Server 10 SP1 64-bit kernel
CPU Characteristics:	1000 MHz HyperTransport technology	Compiler:	QLogic PathScale
CPU MHz:	2000		Compiler Suite, Release 3.0
FPU:	Integrated	Auto Parallel:	No
CPU(s) enabled:	4 cores, 2 chips, 2 cores/chip	File System:	Linux/reiserfs
CPU(s) orderable:	1,2 chips	System State:	Multi-user, run level 3
Primary Cache:	64 KB I + 64 KB D on chip per core	Base Pointers:	64-bit
Secondary Cache:	1 MB I+D on chip per core	Peak Pointers:	32/64-bit
L3 Cache:	None	Other Software:	SmartHeap 8.1 32 bit Library for Linux
Other Cache:	None		None
	Continued on next page		

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Page 1

SPEC CFP2006 Result

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Dell Inc.

PowerEdge 2970 Energy Smart
AMD Opteron 2212 HE, 2.0 GHz

SPECfp_rate2006 =	39.8
SPECfp_rate_base2006 =	37.7

CPU2006 license #:	3184	Test sponsor:		Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies							

Hardware (Continued)

Memory: 16 GB (8x2 GB DDR2 PC2-5300)
Disk Subsystem: SAS, 73 GB
Other Hardware: None

Results Table

Benchmark	Copies	Base Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Peak Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	4	**1030**	**52.6**	1030	52.6	1040	52.5	4	981	55.4	976	55.7	**979**	**55.5**
416.gamess	4	1950	40.2	1950	40.1	**1950**	**40.2**	4	1720	45.7	**1730**	**45.3**	1780	44.0
433.milc	4	1080	33.9	**1080**	**33.9**	1080	33.9	4	**1060**	**34.6**	1060	34.5	1060	34.7
434.zeusmp	4	1030	35.3	**1030**	**35.3**	1030	35.3	4	1020	35.6	1020	35.5	**1020**	**35.6**
435.gromacs	4	793	36.0	**790**	**36.1**	790	36.2	4	695	41.1	**699**	**40.9**	701	40.8
436.cactusADM	4	1270	37.7	**1250**	**38.1**	1250	38.3	4	**1250**	**38.2**	1240	38.6	1250	38.1
437.leslie3d	4	1110	33.9	**1110**	**33.8**	1120	33.6	4	1110	33.9	**1110**	**33.8**	1120	33.6
444.namd	4	923	34.7	921	34.8	**921**	**34.8**	4	870	36.9	869	36.9	**869**	**36.9**
447.dealII	4	839	54.6	839	54.5	**839**	**54.5**	4	667	68.6	**668**	**68.5**	669	68.4
450.soplex	4	**1110**	**30.0**	1110	30.0	1110	30.0	4	986	33.8	**988**	**33.8**	992	33.6
453.povray	4	460	46.2	**460**	**46.3**	459	46.3	4	416	51.1	**417**	**51.1**	418	50.9
454.calculix	4	1540	21.4	1550	21.4	**1540**	**21.4**	4	**1430**	**23.1**	1430	23.0	1430	23.1
459.GemsFDTD	4	1320	32.2	**1330**	**32.0**	1330	32.0	4	1320	32.1	1310	32.5	**1320**	**32.1**
465.tonto	4	892	44.1	887	44.4	**890**	**44.2**	4	892	44.1	887	44.4	**890**	**44.2**
470.lbm	4	**1600**	**34.3**	1630	33.8	1590	34.5	4	**1600**	**34.3**	1630	33.8	1590	34.5
481.wrf	4	996	44.8	1000	44.6	**999**	**44.7**	4	996	44.8	1000	44.6	**999**	**44.7**
482.sphinx3	4	1790	43.6	1780	43.8	**1780**	**43.7**	4	1780	43.9	1790	43.6	**1780**	**43.7**

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

Compiler Invocation

C benchmarks:
    pathcc

C++ benchmarks:
    pathCC

Fortran benchmarks:
    pathf95

Benchmarks using both Fortran and C:
    pathcc pathf95

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Page 2

SPEC CFP2006 Result

Dell Inc.

PowerEdge 2970 Energy Smart
AMD Opteron 2212 HE, 2.0 GHz

SPECfp_rate2006 =	39.8
SPECfp_rate_base2006 =	37.7

CPU2006 license #:	3184	Test sponsor:		Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies							

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

    436.cactusADM: -DSPEC_CPU_LP64 -fno-second-underscore

        481.wrf: -DSPEC_CPU_LP64 -DSPEC_CPU_LINUX -fno-second-underscore

Peak Portability Flags

C benchmarks (except as noted below):
    -DSPEC_CPU_LP64

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

      444.namd: -DSPEC_CPU_LP64

      453.povray: -DSPEC_CPU_LP64

Fortran benchmarks (except as noted below):
    -DSPEC_CPU_LP64

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

    436.cactusADM: -DSPEC_CPU_LP64 -fno-second-underscore

Base Optimization Flags

C benchmarks:
    -Ofast

C++ benchmarks:
    -Ofast

Fortran benchmarks:
    -Ofast -OPT:malloc_alg=1

SPEC CFP2006 Result

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Dell Inc.

| SPECfp_rate2006 = | 39.8 |

PowerEdge 2970 Energy Smart
AMD Opteron 2212 HE, 2.0 GHz

| SPECfp_rate_base2006 = | 37.7 |

| CPU2006 license #: | 3184 | Test sponsor: | Dell Inc. | Test date: | Sep-2007 | Hardware Availability: | Sep-2007 | Software Availability: | Sep-2007 |
| | | Tested by: | Principled Technologies | | | | | | |

Base Optimization Flags (Continued)

Benchmarks using both Fortran and C:
```
-Ofast -OPT:malloc_alg-1
```

Peak Optimization Flags

C benchmarks:

```
433.milc: -Ofast -CG:cflow-off -LNO:prefetch-1 -OPT:malloc_alg-1
```

```
470.lbm: basepeak - yes
```

```
482.sphinx3: -O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -m32
          -OPT:Ofast -WOPT:aggstr-0
```

C++ benchmarks:

```
444.namd: -Ofast -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2)
          -fno-exceptions
```

```
447.dealII: -Ofast -fno-exceptions -INLINE:aggressive-on -m32
          -OPT:malloc_alg-1
```

```
450.soplex: -O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2)
          -fno-exceptions -CG:load_exe-0 -CG:movnti-1
          -LNO:minvariant-off -LNO:prefetch-1 -m32 -OPT:IEEE_arith-3
```

```
453.povray: -Ofast -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2)
          -fno-fast-math
```

Fortran benchmarks (except as noted below):
```
basepeak - yes
```

```
410.bwaves: -O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2)
          -LNO:blocking-off -LNO:ignore_feedback-off -OPT:IEEE_arith-3
          -OPT:Ofast
```

```
416.gamess: -O2 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2)
          -OPT:Ofast -OPT:ro-3 -OPT:unroll_size-256
```

```
434.zeusmp: -Ofast -CG:local_fwd_sched-on -LNO:blocking-off -LNO:fu-10
          -LNO:full_unroll_outer-on -LNO:interchange-off
```

```
459.GemsFDTD: -Ofast -LNO:fission-2 -LNO:prefetch-0
```

Benchmarks using both Fortran and C:

```
435.gromacs: -O3 -OPT:ro-3 -OPT:rsqrt-2
```

```
436.cactusADM: -O3 -fb_create fbdata(pass 1) -fb_opt fbdata(pass 2) -ipa
          -LNO:full_unroll-5 -LNO:ou_prod_max-10 -LNO:prefetch_ahead-5
          -LNO:prefetch-3
```

<small>Continued on next page</small>

SPEC CFP2006 Result

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Dell Inc.

PowerEdge 2970 Energy Smart
AMD Opteron 2212 HE, 2.0 GHz

SPECfp_rate2006 =	39.8
SPECfp_rate_base2006 =	37.7

CPU2006 license #:	3184	Test sponsor:		Dell Inc.	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies							

Peak Optimization Flags (Continued)

454.calculix: -Ofast -LNO:simd=0 -WOPT:mem_opnds=on

481.wrf: basepeak = yes

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

Peak Other Flags

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

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

    447.dealII: -static

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

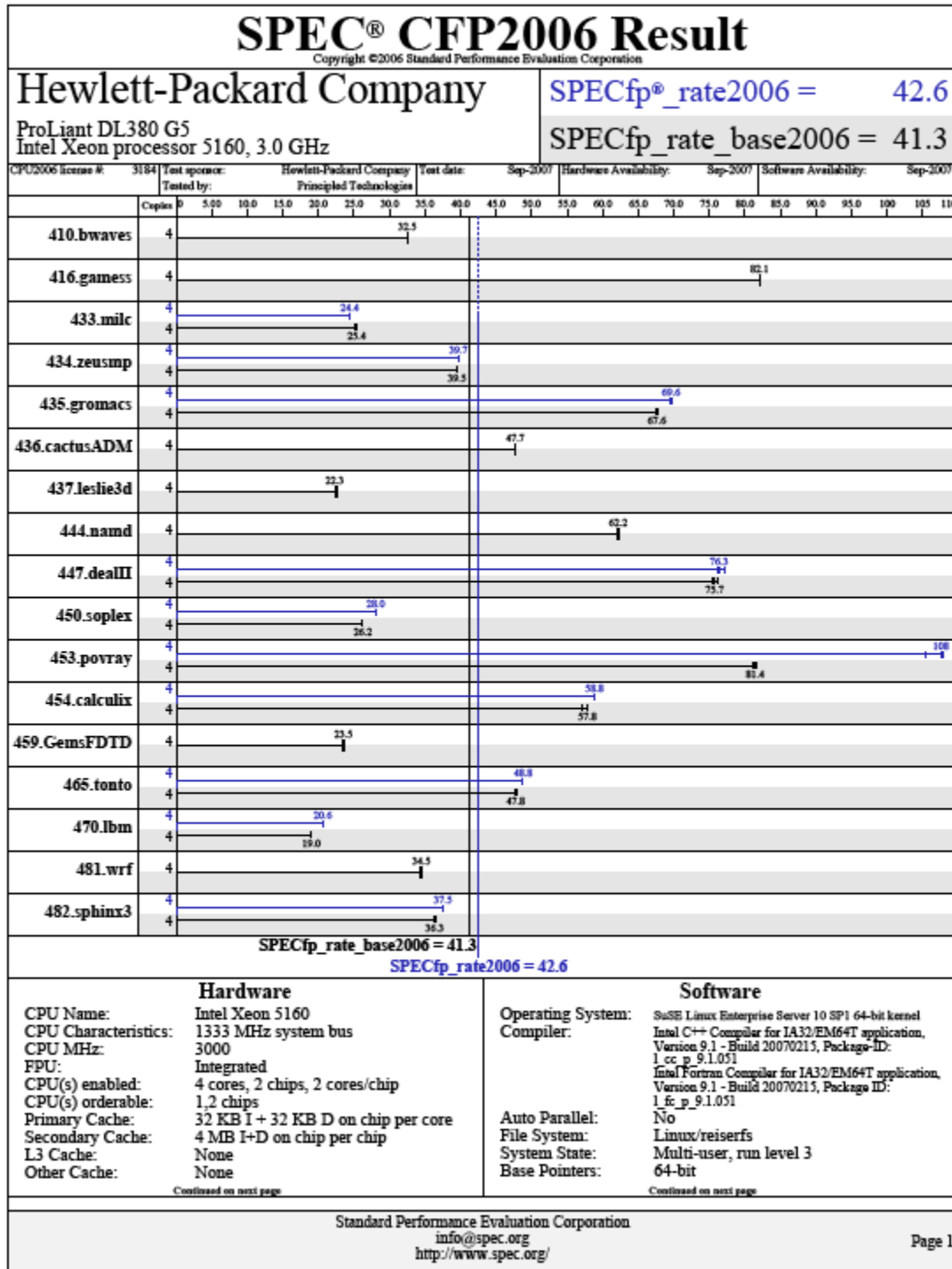Benchmarks using both Fortran and C (except as noted below):
    No flags used

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HP ProLiant DL380 G5 with two Dual-Core Intel Xeon 5160 processors

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Hewlett-Packard Company

ProLiant DL380 G5
Intel Xeon processor 5160, 3.0 GHz

SPECfp®_rate2006 =	42.6
SPECfp_rate_base2006 =	41.3

CPU2006 license #: 3184 Test sponsor: Hewlett-Packard Company Test date: Sep-2007 Hardware Availability: Sep-2007 Software Availability: Sep-2007

Tested by: Principled Technologies

Benchmark	Copies	Result
410.bwaves	4	32.5
416.gamess	4	82.1
433.milc	4	24.4
433.milc	4	25.4
434.zeusmp	4	39.7
434.zeusmp	4	39.5
435.gromacs	4	69.6
435.gromacs	4	67.6
436.cactusADM	4	47.7
437.leslie3d	4	22.3
444.namd	4	62.2
447.dealII	4	76.3
447.dealII	4	73.7
450.soplex	4	28.0
450.soplex	4	26.2
453.povray	4	108
453.povray	4	81.4
454.calculix	4	58.8
454.calculix	4	57.8
459.GemsFDTD	4	23.5
465.tonto	4	48.8
465.tonto	4	47.8
470.lbm	4	20.6
470.lbm	4	19.0
481.wrf	4	34.5
482.sphinx3	4	37.5
482.sphinx3	4	36.3

SPECfp_rate_base2006 = 41.3
SPECfp_rate2006 = 42.6

Hardware		Software	
CPU Name:	Intel Xeon 5160	Operating System:	SuSE Linux Enterprise Server 10 SP1 64-bit kernel
CPU Characteristics:	1333 MHz system bus	Compiler:	Intel C++ Compiler for IA32/EM64T application, Version 9.1 - Build 20070215, Package-ID: l_cc_p_9.1.051
CPU MHz:	3000		
FPU:	Integrated		Intel Fortran Compiler for IA32/EM64T application, Version 9.1 - Build 20070215, Package ID: l_fc_p_9.1.051
CPU(s) enabled:	4 cores, 2 chips, 2 cores/chip		
CPU(s) orderable:	1,2 chips		
Primary Cache:	32 KB I + 32 KB D on chip per core	Auto Parallel:	No
Secondary Cache:	4 MB I+D on chip per chip	File System:	Linux/reiserfs
L3 Cache:	None	System State:	Multi-user, run level 3
Other Cache:	None	Base Pointers:	64-bit
Continued on next page		Continued on next page	

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Page 1

SPEC CFP2006 Result

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Hewlett-Packard Company

ProLiant DL380 G5
Intel Xeon processor 5160, 3.0 GHz

SPECfp_rate2006 =	42.6
SPECfp_rate_base2006 =	41.3

CPU2006 license #:	3184	Test sponsor:	Hewlett-Packard Company	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Hardware (Continued)		Software (Continued)	
Memory:	16 GB (8x2 GB DDR2 PC2-5300)	Peak Pointers:	32/64-bit
Disk Subsystem:	SAS, 73 GB	Other Software:	SmartHeap 8.1 32 bit Library for Linux
Other Hardware:	None		None

Results Table

Benchmark	Copies	Base Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Peak Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	4	1670	32.6	1670	32.5	**1670**	**32.5**	4	1670	32.6	1670	32.5	**1670**	**32.5**
416.gamess	4	**954**	**82.1**	954	82.1	954	82.1	4	**954**	**82.1**	954	82.1	954	82.1
433.milc	4	1440	25.4	1460	25.2	**1450**	**25.4**	4	**1510**	**24.4**	1510	24.4	1510	24.4
434.zeusmp	4	**922**	**39.5**	922	39.5	922	39.5	4	**917**	**39.7**	917	39.7	917	39.7
435.gromacs	4	422	67.6	422	67.7	**422**	**67.6**	4	**410**	**69.6**	410	69.6	411	69.5
436.cactusADM	4	1000	47.7	1000	47.8	**1000**	**47.7**	4	1000	47.7	1000	47.8	**1000**	**47.7**
437.leslie3d	4	**1690**	**22.3**	1660	22.6	1690	22.3	4	**1690**	**22.3**	1660	22.6	1690	22.3
444.namd	4	515	62.3	**516**	**62.2**	517	62.1	4	515	62.3	**516**	**62.2**	517	62.1
447.dealII	4	600	76.3	**604**	**75.7**	607	75.4	4	**599**	**76.3**	594	77.1	600	76.2
450.soplex	4	1280	26.1	**1270**	**26.2**	1270	26.2	4	1190	28.1	**1190**	**28.0**	1190	28.0
453.povray	4	**261**	**81.4**	261	81.6	262	81.1	4	**198**	**108**	202	105	197	108
454.calculix	4	**571**	**57.8**	578	57.1	570	57.9	4	562	58.7	**561**	**58.8**	560	58.9
459.GemsFDTD	4	1800	23.5	**1800**	**23.5**	1800	23.5	4	1800	23.5	**1800**	**23.5**	1800	23.5
465.tonto	4	822	47.9	**824**	**47.8**	825	47.7	4	807	48.8	809	48.6	**807**	**48.8**
470.lbm	4	2890	19.0	**2890**	**19.0**	2890	19.0	4	2670	20.6	**2670**	**20.6**	2670	20.6
481.wrf	4	1300	34.3	1290	34.6	**1300**	**34.5**	4	1300	34.3	1290	34.6	**1300**	**34.5**
482.sphinx3	4	2150	36.3	**2140**	**36.3**	2140	36.4	4	2070	37.6	2080	37.5	**2080**	**37.5**

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

General Notes

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

Base Compiler Invocation

C benchmarks:
    icc

C++ benchmarks:
    icpc

Fortran benchmarks:
    ifort

Continued on next page

Page 2

SPEC CFP2006 Result

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Hewlett-Packard Company

ProLiant DL380 G5
Intel Xeon processor 5160, 3.0 GHz

SPECfp_rate2006 =	42.6
SPECfp_rate_base2006 =	41.3

CPU2006 license #:	3184	Test sponsor:	Hewlett-Packard Company	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Base Compiler Invocation (Continued)

Benchmarks using both Fortran and C:
```
ifort icc
```

Peak Compiler Invocation

C benchmarks:
```
/opt/intel/cc/9.1.051/bin/icc -I/opt/intel/cc/9.1.051/include
-L/opt/intel/cc/9.1.051/lib
```

C++ benchmarks (except as noted below):
```
icpc
```

```
    450.soplex: /opt/intel/cc/9.1.051/bin/icpc
                -I/opt/intel/cc/9.1.051/include -L/opt/intel/cc/9.1.051/lib
```

Fortran benchmarks:

```
    434.zeusmp: /opt/intel/fc/9.1.051/bin/ifort
                -I/opt/intel/fc/9.1.051/include -L/opt/intel/fc/9.1.051/lib
```

```
    465.tonto: ifort
```

Benchmarks using both Fortran and C (except as noted below):
```
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
```

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Page 3

SPEC CFP2006 Result

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Hewlett-Packard Company	SPECfp_rate2006 =	42.6
ProLiant DL380 G5 Intel Xeon processor 5160, 3.0 GHz	SPECfp_rate_base2006 =	41.3

CPU2006 license #:	3184	Test sponsor:	Hewlett-Packard Company	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Peak Portability Flags

C benchmarks:
    No flags used

C++ benchmarks:

     447.dealII: -DSPEC_CPU_LP64

     450.soplex: No flags used

     453.povray: -DSPEC_CPU_LP64

Fortran benchmarks:

     434.zeusmp: No flags used

     465.tonto: -DSPEC_CPU_LP64

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

Base Optimization Flags

C benchmarks:
    -fast

C++ benchmarks:
    -fast

Fortran benchmarks:
    -fast

Benchmarks using both Fortran and C:
    -fast

Peak Optimization Flags

C benchmarks (except as noted below):
    -fast -prof_gen(pass 1) -prof_use(pass 2)

    482.sphinx3: -fast

C++ benchmarks (except as noted below):
    -fast -prof_gen(pass 1) -prof_use(pass 2)

    444.namd: basepeak = yes

Fortran benchmarks (except as noted below):
    basepeak = yes

Page 4

SPEC CFP2006 Result

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Hewlett-Packard Company	SPECfp_rate2006 =	42.6
ProLiant DL380 G5 Intel Xeon processor 5160, 3.0 GHz	SPECfp_rate_base2006 =	41.3

CPU2006 license #:	3184	Test sponsor:	Hewlett-Packard Company	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Peak Optimization Flags (Continued)

434.zeusmp: -fast

465.tonto: -fast -prof_gen(pass 1) -prof_use(pass 2)

Benchmarks using both Fortran and C (except as noted below):
-fast -prof_gen(pass 1) -prof_use(pass 2)

436.cactusADM: basepeak - yes

481.wrf: basepeak - yes

Other Flags

C benchmarks:
No flags used

C++ benchmarks:
No flags used

Fortran benchmarks:
No flags used
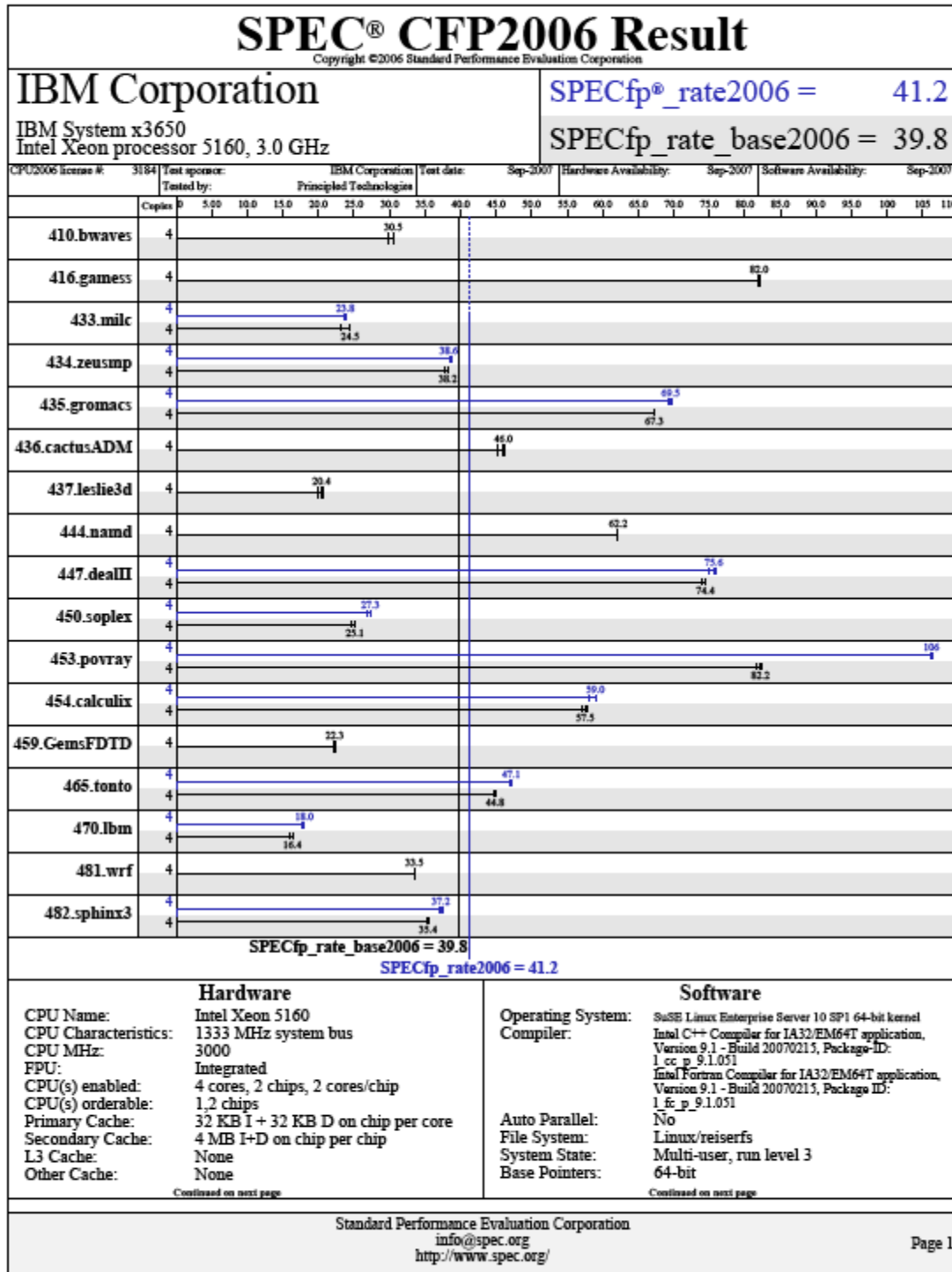
Benchmarks using both Fortran and C:
No flags used

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Page 5

IBM System x3650 with two Dual-Core Intel Xeon 5160 processors

SPEC® CFP2006 Result
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IBM Corporation

IBM System x3650
Intel Xeon processor 5160, 3.0 GHz

SPECfp®_rate2006 =	41.2
SPECfp_rate_base2006 =	39.8

CPU2006 license #: 3184 Test sponsor: IBM Corporation Test date: Sep-2007 Hardware Availability: Sep-2007 Software Availability: Sep-2007
Tested by: Principled Technologies

Benchmark	Copies	Result
410.bwaves	4	30.5
416.gamess	4	82.0
433.milc	4 / 4	23.8 / 24.5
434.zeusmp	4 / 4	38.6 / 38.2
435.gromacs	4 / 4	69.5 / 67.3
436.cactusADM	4	46.0
437.leslie3d	4	20.4
444.namd	4	62.2
447.dealII	4 / 4	75.6 / 74.4
450.soplex	4 / 4	27.3 / 25.1
453.povray	4 / 4	106 / 82.2
454.calculix	4 / 4	59.0 / 57.5
459.GemsFDTD	4	22.3
465.tonto	4 / 4	47.1 / 44.8
470.lbm	4 / 4	18.0 / 16.4
481.wrf	4	33.5
482.sphinx3	4 / 4	37.2 / 35.4

SPECfp_rate_base2006 = 39.8
SPECfp_rate2006 = 41.2

Hardware
CPU Name:	Intel Xeon 5160
CPU Characteristics:	1333 MHz system bus
CPU MHz:	3000
FPU:	Integrated
CPU(s) enabled:	4 cores, 2 chips, 2 cores/chip
CPU(s) orderable:	1,2 chips
Primary Cache:	32 KB I + 32 KB D on chip per core
Secondary Cache:	4 MB I+D on chip per chip
L3 Cache:	None
Other Cache:	None

Continued on next page

Software
Operating System:	SuSE Linux Enterprise Server 10 SP1 64-bit kernel
Compiler:	Intel C++ Compiler for IA32/EM64T application, Version 9.1 - Build 20070215, Package-ID: l_cc_p_9.1.051 Intel Fortran Compiler for IA32/EM64T application, Version 9.1 - Build 20070215, Package ID: l_fc_p_9.1.051
Auto Parallel:	No
File System:	Linux/reiserfs
System State:	Multi-user, run level 3
Base Pointers:	64-bit

Continued on next page

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Page 1

SPEC CFP2006 Result

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SPECfp_rate2006 =	**41.2**
SPECfp_rate_base2006 =	**39.8**

IBM System x3650
Intel Xeon processor 5160, 3.0 GHz

CPU2006 license #:	3184	Test sponsor:	IBM Corporation	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Hardware (Continued)		Software (Continued)	
Memory:	16 GB (8x2 GB DDR2 PC2-5300)	Peak Pointers:	32/64-bit
Disk Subsystem:	SAS, 73 GB	Other Software:	SmartHeap 8.1 32 bit Library for Linux
Other Hardware:	None		None

Results Table

Benchmark	Copies	Base Seconds	Ratio	Seconds	Ratio	Seconds	Ratio	Copies	Peak Seconds	Ratio	Seconds	Ratio	Seconds	Ratio
410.bwaves	4	1830	29.8	**1780**	**30.5**	1780	30.5	4	1830	29.8	**1780**	**30.5**	1780	30.5
416.gamess	4	955	82.0	**955**	**82.0**	955	82.0	4	955	82.0	**955**	**82.0**	955	82.0
433.milc	4	1580	23.2	1500	24.5	**1500**	**24.5**	4	1550	23.7	1530	24.0	**1540**	**23.8**
434.zeusmp	4	963	37.8	**953**	**38.2**	950	38.3	4	943	38.6	**943**	**38.6**	937	38.8
435.gromacs	4	**425**	**67.3**	424	67.4	425	67.2	4	412	69.3	410	69.6	**411**	**69.5**
436.cactusADM	4	1060	45.2	1030	46.3	**1040**	**46.0**	4	1060	45.2	1030	46.3	**1040**	**46.0**
437.leslie3d	4	1880	20.0	**1840**	**20.4**	1820	20.7	4	1880	20.0	**1840**	**20.4**	1820	20.7
444.namd	4	**516**	**62.2**	517	62.1	516	62.2	4	**516**	**62.2**	517	62.1	516	62.2
447.dealII	4	**615**	**74.4**	614	74.5	618	74.0	4	**605**	**75.6**	603	75.9	611	74.9
450.soplex	4	1360	24.5	1330	25.1	**1330**	**25.1**	4	1240	26.9	1220	27.3	**1220**	**27.3**
453.povray	4	261	81.6	**259**	**82.2**	258	82.4	4	200	106	200	106	**200**	**106**
454.calculix	4	571	57.8	578	57.1	**574**	**57.5**	4	569	58.0	560	59.0	**560**	**59.0**
459.GemsFDTD	4	1920	22.1	1900	22.3	**1900**	**22.3**	4	1920	22.1	1900	22.3	**1900**	**22.3**
465.tonto	4	881	44.7	**878**	**44.8**	877	44.9	4	837	47.0	**836**	**47.1**	833	47.3
470.lbm	4	3430	16.0	**3360**	**16.4**	3340	16.5	4	3090	17.8	**3050**	**18.0**	3040	18.1
481.wrf	4	1340	33.4	1330	33.5	**1330**	**33.5**	4	1340	33.4	1330	33.5	**1330**	**33.5**
482.sphinx3	4	2210	35.3	2190	35.6	**2200**	**35.4**	4	2110	36.9	**2090**	**37.2**	2070	37.6

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

General Notes

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

Base Compiler Invocation

C benchmarks:
   icc

C++ benchmarks:
   icpc

Fortran benchmarks:
   ifort

Page 2

SPEC CFP2006 Result

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IBM System x3650
Intel Xeon processor 5160, 3.0 GHz

SPECfp_rate2006 =	41.2
SPECfp_rate_base2006 =	39.8

CPU2006 license #:	3184	Test sponsor:	IBM Corporation	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Base Compiler Invocation (Continued)

Benchmarks using both Fortran and C:
```
ifort icc
```

Peak Compiler Invocation

C benchmarks:
```
/opt/intel/cc/9.1.051/bin/icc -I/opt/intel/cc/9.1.051/include
-L/opt/intel/cc/9.1.051/lib
```

C++ benchmarks (except as noted below):
```
icpc
```
```
450.soplex: /opt/intel/cc/9.1.051/bin/icpc
            -I/opt/intel/cc/9.1.051/include -L/opt/intel/cc/9.1.051/lib
```

Fortran benchmarks:
```
434.zeusmp: /opt/intel/fc/9.1.051/bin/ifort
            -I/opt/intel/fc/9.1.051/include -L/opt/intel/fc/9.1.051/lib
```
```
465.tonto: ifort
```

Benchmarks using both Fortran and C (except as noted below):
```
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
```

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Page 3

SPEC CFP2006 Result

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IBM Corporation

IBM System x3650
Intel Xeon processor 5160, 3.0 GHz

SPECfp_rate2006 =	41.2
SPECfp_rate_base2006 =	39.8

CPU2006 license #:	3184	Test sponsor:		IBM Corporation	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:		Principled Technologies						

Peak Portability Flags

C benchmarks:
    No flags used

C++ benchmarks:

      447.dealII: -DSPEC_CPU_LP64

      450.soplex: No flags used

      453.povray: -DSPEC_CPU_LP64

Fortran benchmarks:

      434.zeusmp: No flags used

      465.tonto: -DSPEC_CPU_LP64

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

Base Optimization Flags

C benchmarks:
    -fast

C++ benchmarks:
    -fast

Fortran benchmarks:
    -fast

Benchmarks using both Fortran and C:
    -fast

Peak Optimization Flags

C benchmarks (except as noted below):
    -fast -prof_gen(pass 1) -prof_use(pass 2)

    482.sphinx3: -fast

C++ benchmarks (except as noted below):
    -fast -prof_gen(pass 1) -prof_use(pass 2)

    444.namd: basepeak = yes

Fortran benchmarks (except as noted below):
    basepeak = yes

Continued on next page

Page 4

SPEC CFP2006 Result

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IBM Corporation

IBM System x3650
Intel Xeon processor 5160, 3.0 GHz

SPECfp_rate2006 =	41.2
SPECfp_rate_base2006 =	39.8

CPU2006 license #:	3184	Test sponsor:	IBM Corporation	Test date:	Sep-2007	Hardware Availability:	Sep-2007	Software Availability:	Sep-2007
		Tested by:	Principled Technologies						

Peak Optimization Flags (Continued)

434.zeusmp: -fast

465.tonto: -fast -prof_gen(pass 1) -prof_use(pass 2)

Benchmarks using both Fortran and C (except as noted below):
-fast -prof_gen(pass 1) -prof_use(pass 2)

436.cactusADM: basepeak - yes

481.wrf: basepeak - yes

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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Page 5

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