Principled Technologies®

TEST REPORT
JUNE 2006

Performance comparison of Intel C++ Compiler 9.1 for Linux and GNU gcc 4.1.1 on AMD- and Intel-processor-based systems

Executive summary

Intel Corporation (Intel) commissioned Principled Technologies (PT) to measure and compare 64-bit, multi-threaded, floating-point application performance using an industry standard benchmark (SPEC CPU2000 SPECfp_rate_base) with leading software compilers on the latest available dual-core 2-way servers. PT created the necessary executables with the Intel C++ Compiler 9.1 and GNU gcc 4.1.1 on the following two similarly configured servers:

- Dual-Core AMD Opteron 285-based server with 8GB of DDR2 memory
- Dual-Core Intel Xeon Processor 5160-based server with 8GB of FBD memory

In Figure 1, we show the best results for each compiler on each server. For details of the performance of each compiler and server, see the Test results section.

KEY FINDINGS

- **Compiler:** The Intel C++ Compiler 9.1 outperformed the GNU gcc 4.1.1 compiler by a significant margin while running an industry-standard benchmark (SPECfp_rate_base) on both the AMD Opteron 285-based server and the Intel Xeon Processor 5160-based server.
- **System:** The Intel Xeon Processor 5160-based server outperformed the AMD Opteron 285-based server on versions of SPECfp_rate_base we built with both the GNU gcc 4.1.1 and the Intel C++ 9.1 compilers.

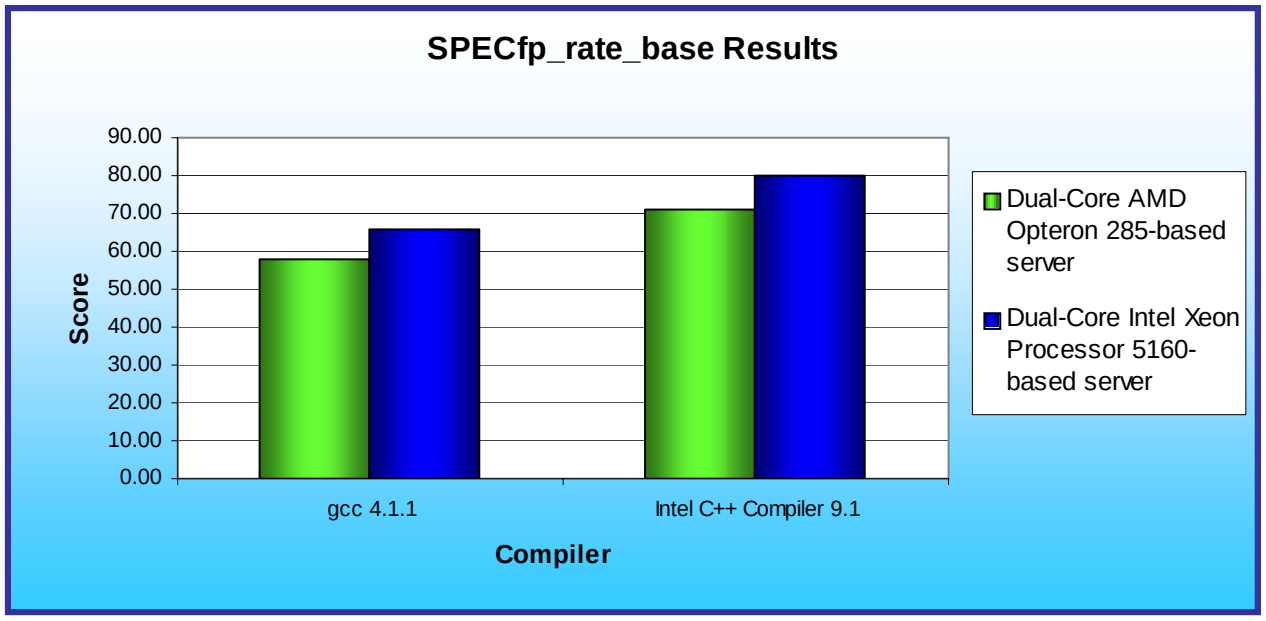


Figure 1: SPECfp_rate_base results for the two test servers running the two compilers.

SPEC CPU2000 Workload

SPEC CPU2000 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. SPEC CPU2000 consists of two benchmark suites, each of which focuses on a different aspect of compute-intensive performance. CINT2000 measures and compares compute-intensive integer performance, while CFP2000 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 CFP2000 SPECfp_rate_base benchmark. (For more information on SPEC CPU2000 and other SPEC benchmarks, see www.spec.org.)

The SPEC CPU2000 workload includes two benchmark suites: CINT2000 and CFP2000. We ran only the CFP2000 benchmark, which focuses on measuring and comparing compute-intensive floating-point performance. Specifically, we measured the SPECfp_rate_base2000 results for the two compilers and test servers with four benchmark "users" (simultaneously running copies of the benchmark). This number typically equals the number of physical cores in a processor for maximum performance. The workload's result is the average of fourteen normalized throughput ratios. Figure 2 lists the fourteen components of CFP2000 and their respective languages that compose the CFP2000 benchmark.

Name	Language	Remarks
168.wupwise	Fortran 77	Physics/Quantum chromodynamics
171.swim	Fortran 77	FPGA circuit placement and routing
172.mgrid	Fortran 77	Multi-grid solver: 3D potential field
173.applu	Fortran 77	Parabolic/Elliptic partial differential equations
177.mesa	C	3D graphics library
178.galgel	Fortran 90	Computational fluid dynamics
179.art	C	Image recognition/Neural networks
183.equake	C	Seismic wave propagation simulation
187.facerec	Fortran 90	Image processing: Face recognition
188.ammp	C	Computational chemistry
189.lucas	Fortran 90	Number theory/Primality testing
191.fma3d	Fortran 90	Finite-element crash simulation
200.sixtrack	Fortran 77	High energy nuclear physics accelerator design
301.aspi	Fortran 77	Meteorology: Pollutant distribution

Figure 2: The applications that make up the CFP2000 benchmark.

A CFP2000 run performs each of the 14 application (tasks) three times and reports the median for each. It also calculates the geometric mean of those 14 results to produce an overall score. A corresponding rate run executes the same test simultaneously for multiple users. In these tests, that number of users was set to four. We built the benchmark with each compiler using conservative optimization.

Test results

Figure 3 shows the SPECfp_rate_base2000 results for both servers and both compilers with four users. (In SPEC’s terms, these results are estimates, meaning we are not posting them on the SPEC Web site with all the SPEC required files. We do present here all the data necessary to reproduce these results.) The comparative result is relative to the performance of the AMD-based system; a higher comparative result indicates better performance.

Compiler \ System	Dual-Core AMD Opteron 285-based server	Dual-Core Intel Xeon Processor 5160-based server	Comparative Result (System)
GNU gcc 4.1.1	57.9	65.8	1.14
Intel C++ Compiler 9.1	70.8	80.1	1.13
Comparative Result (Compiler)	1.22	1.22	

Figure 3: SPECfp_rate_base results for both compilers and servers with the number of users set to four. Higher numbers are better.

Test methodology

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

Server	Dual-Core AMD Opteron 285-based server	Dual-Core Intel Xeon Processor 5160-based server
Processor frequency (GHz)	2.6GHz	3.0GHz
Single/Dual-Core processors	2 dual-core processors	2 dual-core processors
Motherboard	UNIWIDE Technologies SS232-128-03	Supermicro X7DB8+
Chipset	NVIDIA nForce4 chipset	Intel 5000P Chipset
RAM (8GB in each)	8 x 1GB PC-3200	8 x 1GB PC2-5300 FBDIMM
Hard Drive	Western Digital WD1600YD	Western Digital WD1600YD

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

Intel configured and provided both servers.

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

We began by installing a fresh copy of Fedora Core 5 on each server. We followed this process for each installation:

1. Set the hostname to manual, and enter “Server” as the hostname.
2. Select “remove all partitions”.
3. Uncheck “Office and Productivity”.
4. Check “Software Development”.

We applied the following updates using the yum package update client the Fedora distribution included. (We used the command: “yum update kernel gcc”.)

- kernel-2.6.16-1.2133_FC5.x86_64

- gcc-4.1.1-1.fc5.x86_64
- gcc-4.1.1-1.fc5.x86_64
- cpp-4.1.1-1.fc5.x86_64
- gcc-c++-4.1.1-1.fc5.x86_64
- gcc-gfortran-4.1.1-1.fc5.x86_64
- libgcc-4.1.1-1.fc5.x86_64
- libgfortran-4.1.1-1.fc5.x86_64
- libgomp-4.1.1-1.fc5.x86_64
- libstdc++-4.1.1-1.fc5.x86_64
- libstdc++-devel-4.1.1-1.fc5.x86_64
- libtool-1.5.22-2.3.x86_64

SPECCPU2000 configuration

We followed SPEC's standard instructions for building the CFP2000 executables. We used the following compilers:

- Intel Compiler:
  - Intel C++ Compiler 9.1.038 for EM64T Build 20060323
  - Intel Fortran Compiler 9.1.032 for EM64T Build 20060323
- GNU gcc Compiler:
  - GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
  - GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)

The benchmark requires configuration files. From the SPEC Web site we chose the most recent (as of the testing for this report) published SPECCPU2000 results that used an Intel compiler on the Linux operating system. We copied the configuration files for those results and used them, with modifications to reflect the appropriate system information about the servers under test, in our testing. As of the testing for this report, there were no gcc version 4 or newer compiler results on the SPEC Web to use as references. We consequently began with the example SPEC configuration file "`linux-amd64-gcc4.cfg`" that came with SPEC CPU2000 and optimized for each platform. Appendixes B, C, D, and E provide the configuration files we used for each compiler and each server.

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 those tests. (SPEC also offers options for more aggressive, or "peak," tests. We are not reporting those results here and did not run those tests.)

To install SPECCPU2000, we performed the following steps:

1. Extract SPECCPU2000v1.3 to the `/cpu2000` directory.
2. From the command line, change to the `/cpu2000` directory.
3. Type '`./install.sh`' at the command prompt to run the installer. A list of valid toolsets will be displayed.
4. Enter "`linux-glibc22-x86_64`" as the architecture you are using and the installer will select the appropriate toolset.

To begin the benchmark, we performed the following steps:

1. Reboot the computer.
2. After rebooting, do **NOT** log in from the GUI. Instead, press Ctrl-Alt-F1 to go to a command-line terminal. Log in there.
3. Once logged in, type '`init 3`'. Note that this may blank the screen. If it does, press Ctrl-Alt-F1 again.
4. Change to the `/cpu2000` directory.
5. Type `sh` to start a Bourne-compatible shell at the command prompt.

6. Type '`. ./shrc`' at the command prompt. The space between the dots is necessary for the command to work properly.
7. Enter "`runspec -c <config file name> -T base -r -u <#> --reportable fp`", where
   - <config file name> = name of the configuration file
   - <#> = is 2 or 4, depending on the number of users (for all our testing, this was set to 4)

When the run completes, the benchmark puts the results in the directory /cpu2000/result. The result file names are of the form CFP2000.<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. CFP2000.002, asc and log.002.

Appendix A – Test server configuration information

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

Processors	Dual-Core AMD Opteron 285	Dual-Core Intel Xeon Processor 5160
System configuration information		
General		
Processor and OS kernel: (physical, core, logical) / (UP, MP)	2P4C4L / MP	2P4C4L / MP
Number of physical processors	2	2
Single/Dual-core processors	Dual	Dual
System Power Management Policy	Always On	Always On
CPU		
System type	Server	Server
Vendor	AMD	Intel
Name	Dual-Core AMD Opteron 285	Dual-Core Intel Xeon Processor 5160
Stepping	2	4
Socket type	940	LGA775
Core frequency (GHz)	2.6 GHz	3.0 GHz
Front-side bus frequency (MHz)	2000 MHz HyperTransport	1333 MHz Dual Independent Busses (DIB)
L1 Cache	64KB + 64KB	32KB + 32KB
L2 Cache	2MB (1MB per core)	4MB (Shared)
Platform		
Vendor and model number	Dual-Core AMD Opteron 285 server	Dual-Core Intel Xeon Processor 5160 server
Motherboard model number	UNIWIDE_SS232-128-03	Supermicro X7DB8+
Motherboard chipset	NVIDIA nForce4 Chipset	Intel 5000P Chipset
Motherboard revision number	A3	92
Motherboard serial number	WTOPHTSA01020	TM63S00221
BIOS name and version	American Megatrends Inc. 080012, 3/21/2006	Phoenix Technologies 6.00 5/03/2006
BIOS settings	Default	Default
Memory module(s)		
Vendor and model number	Corsair CMX1024RE-32000	Micron MT18HTF12872FDY
Type	PC-3200	PC2-5300
Speed (MHz)	400 MHz	667 MHz
Speed in the system currently running @ (MHz)	400 MHz	667 MHz
Timing/Latency (tCL-tRCD-tRP-tRASmin)	3-3-3-8	5-5-5-12
Size	8192MB	8192MB
Number of sticks	8	8
Chip organization	Double-sided	Double-sided
Channel	Dual	Dual
Hard disk		
Vendor and model number	Western Digital WD1600YD	Western Digital WD1600YD
Number of disks in system	1	1

Size	160GB	160GB
Buffer Size	16MB	16MB
RPM	7500	7500
Type	SATA	SATA
Controller	NVIDIA nForce4 Serial ATA	Intel 631xESB Serial ATA
Operating system		
Name	Fedora Core release 5 (Bordeaux)	Fedora Core release 5 (Bordeaux)
Kernel update date	6/19/2006	6/19/2006
File system	ext3	ext3
Kernel	Kernel 2.6.16-1.2133_FC5	Kernel 2.6.16-1.2133_FC5
Platform	x86_64	x86_64
Language	English	English
Graphics		
Vendor and model number	ATI Rage XL	ATI Rage XL
Chipset	ATI Rage XL PCI	ATI Rage XL PCI
BIOS version	GR-xlacrs3p.003-4.328	GR-xlints3y.09a-4.332
Type	Integrated	Integrated
Memory size	8MB	8MB
Resolution	1024 x 768	1024 x 768
Network card/subsystem		
Vendor and model number	Broadcom dual NetXtreme Gigabit	Intel PRO/1000 EB Network Connection
Type	Integrated	Integrated
Additional network card information	2 x Intel PRO/1000 PT Dual Port Server Adapter	2 x Intel PRO/1000 PT Dual Port Server Adapter
Optical drive		
Vendor and model number	Samsung SN-124	LITE-ON SOHC-5236V
Type	CD-ROM	DVD/CDRW
Interface	Internal	Internal
USB ports		
# of ports	4	4
Type of ports (USB1.1, USB2.0)	USB 2.0	USB 2.0

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

Appendix B – Configuration file for the GNU gcc 4.1.1 compiler on the Intel processor-based server

This appendix contains the benchmark configuration file we used to test the Dual-Core Intel Xeon Processor 5160-based server using the GNU gcc 4.1.1 compiler.

```
# Invocation command line:
# /cpu2000/bin/runspec -c linux-nocona-gcc4.1.1.cfg -T base -r -u 4 --reportable fp
############################################################################
# SPEC2000 configuration file for Intel "nocona" and GCC 4.1.1
############################################################################

company_name      = Principled Technologies
hw_cpu            = Dual-Core Intel Xeon Processor 5160 ( 3.0GHz, 1333 MHz bus)
hw_cpu_mhz        = 3000
hw_disk           = SATA, 160 GB
hw_fpu            = Integrated
hw_memory         = 8 x 1GB, PC2-5300
hw_vendor         = Intel
hw_model          = Supermicro X7DB8 motherboard( 3.0 GHz, Dual-Core Intel Xeon Processor 5160)
hw_avail  =
hw_ncpu           = 4 cores, 2 chips, 2 core/chip
hw_ncpuorder      = 1,2
hw_ocache         = N/A
hw_other  = None
hw_parallel       = No
hw_pcache         = 32KBI + 32KBD on chip
hw_scache         = 4MB (Shared)
hw_tcache         = N/A
sw_file           = Linux/ext3
sw_os             = Fedora Core 5
sw_state  = Multi-user Run level 3


VENDOR            = Intel
action            = validate
tune              = base
output_format     = asc,html,config,ps,pdf
ext               = gcc4-high-opt

check_md5         = 1
reportable        = 1
feedback  = 1
ONESTEP                   = 1
basepeak = yes

expand_notes      = 1

teeout=yes
teerunout=yes

#
# These are listed as benchmark-tuning-extension-machine
#
default=default=default=default:
CC       = gcc
CXX      = g++
FC       = gfortran
F77      = gfortran

#############################################################
# Architecture Optimization
#############################################################

# High Optimization:
default=base=gcc4-high-opt=default:
```

```
CARCH_FLAGS= -march=nocona -m64
CXXARCH_FLAGS= -march=nocona -m64
FARCH_FLAGS= -march=nocona -m64

#####################################################################
# Portability Flags
#####################################################################

255.vortex=default=default=default:
notes0045=   255.vortex=  CPORTABILITY=-DSPEC_CPU2000_LP64
CPORTABILITY      = -DSPEC_CPU2000_LP64

186.crafty=default=default=default:
notes0050=   186.crafty:  CPORTABILITY=-DLINUX_i386
CPORTABILITY      = -DLINUX_i386

252.eon=default=default=default:
notes0051=   252.eon:     CXXPORTABILITY=-DHAS_ERRLIST -DSPEC_CPU2000_LP64
CXXPORTABILITY = -DHAS_ERRLIST -DSPEC_CPU2000_LP64

253.perlbmk=default=default=default:
notes0052=   253.perlbmk: CPORTABILITY=-DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL
notes0053=                -DSPEC_CPU2000_LP64
CPORTABILITY      = -DSPEC_CPU2000_NEED_BOOL -DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_LP64

254.gap=default=default=default:
notes0055=   254.gap:     CPORTABILITY=-DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO
notes0056=                -DSYS_HAS_CALLOC_PROTO -DSYS_HAS_MALLOC_PROTO
notes0057=                -DSPEC_CPU2000_LP64
CPORTABILITY      = -DSYS_HAS_MALLOC_PROTO -DSYS_HAS_CALLOC_PROTO -DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -
DSYS_HAS_TIME_PROTO -DSPEC_CPU2000_LP64

178.galgel=default=default=default:
notes0050=    178.galgel:     -ffixed-form
FPORTABILITY= -ffixed-form


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

#
# int2000
# Base tuning default optimization
#
int=base=gcc4-low-opt=default:
notes0080=  Baseline C:   gcc -O2
COPTIMIZE           = -O2

# High Optimization:
int=base=gcc4-high-opt=default:
notes0080=  Baseline C:   gcc -O3 ${CARCH_FLAGS}
notes0085=  Baseline C++: g++ -O3 ${CXXARCH_FLAGS}
COPTIMIZE           = -O3 ${CARCH_FLAGS}
PASS1_CFLAGS    = -fprofile-generate
PASS2_CFLAGS    = -fprofile-use
CXXOPTIMIZE       = -O3 ${CXXARCH_FLAGS}
PASS1_CXXFLAGS              = -fprofile-generate
PASS2_CXXFLAGS              = -fprofile-use
PASS1_LDFLAGS  = -fprofile-generate
PASS2_LDFLAGS  = -fprofile-use


#
# fp2000
# Base tuning default optimization
#
#             Fortran benchmarks
#
```

```
fp=base=gcc4-low-opt=default:
notes0085=  Baseline: Fortran gfortran -O2
notes0080=  Baseline: C       gcc -O2
FOPTIMIZE           = -O2
F77OPTIMIZE         = -O2
COPTIMIZE           = -O2

#High Optimization:

fp=base=gcc4-high-opt=default:
notes0080=  Baseline: C       gcc      -O3 ${CARCH_FLAGS}
notes0085=  Baseline: Fortran gfortran -O3 ${FARCH_FLAGS}
COPTIMIZE           = -O3 ${CARCH_FLAGS}
PASS1_CFLAGS    = -fprofile-generate
PASS2_CFLAGS    = -fprofile-use
FOPTIMIZE           = -O3 ${FARCH_FLAGS}
PASS1_FFLAGS    = -fprofile-generate
PASS2_FFLAGS    = -fprofile-use
PASS1_LDFLAGS   = -fprofile-generate
PASS2_LDFLAGS   = -fprofile-use


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

#
# int2000
# Peak tuning
#

int=peak=default=default:
notes0087=   All peak: basepeak=yes
basepeak = yes

#
# fp2000
# Peak tuning
#

fp=peak=default=default:
notes0087=   All peak: basepeak=yes
basepeak = yes


######################################################################
# Default Compiler Flags
######################################################################

int=default=default=default:
notes0030=  Portability:
sw_avail= June-2006
sw_compiler0000= GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
sw_compiler0001= GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)


fp=default=default=default:
sw_avail= June-2006
sw_compiler0000= GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
sw_compiler0001= GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
```

Appendix C – Configuration file for the GNU gcc 4.1.1 compiler on the AMD processor-based server

This appendix contains the configuration file we used to test the Dual-Core AMD Opteron 285-based server using the GNU gcc 4.1.1 compiler.

```
# Invocation command line:
# /cpu2000/bin/runspec -c linux-opteron-gcc4.1.1.cfg -T base -r -u 4 --reportable fp
############################################################################

############################################################################
# SPEC2000 configuration file for AMD "opteron" and GCC 4.1.1
############################################################################

company_name      = Principled Technologies
hw_cpu            = Dual-Core AMD Opteron 285 ( 2.6 GHz, 2000 MHz HT)
hw_cpu_mhz        = 2600
hw_disk           = SATA, 160 GB
hw_fpu            = Integrated
hw_memory         = 8 x 1GB, PC-3200
hw_vendor         = AMD
hw_model          = UNIWIDE Technologies SS232-128-03, AMD Opteron (TM) 285
hw_avail  =
hw_ncpu           = 4 cores, 2 chips, 2 core/chip
hw_ncpuorder      = 1,2
hw_ocache         = N/A
hw_other = None
hw_parallel       = No
hw_pcache         = 64KBI + 64KBD on chip
hw_scache         = 2MB (1MB per core)
hw_tcache         = N/A
sw_file           = Linux/ext3
sw_os             = Fedora Core 5
sw_state  = Multi-user Run level 3


VENDOR            = AMD
action            = validate
tune              = base
output_format     = asc,html,config,ps,pdf
ext               = gcc4-high-opt

check_md5         = 1
reportable        = 1
ONESTEP                   = 1
basepeak = yes

teeout=yes
teerunout=yes

#
# These are listed as benchmark-tuning-extension-machine
#
default=default=default=default:
CC      = gcc
CXX     = g++
FC      = gfortran
F77     = gfortran

#####################################################################
# Architecture Optimization
#####################################################################

# High Optimization:
default=base=gcc4-high-opt=default:
CARCH_FLAGS= -march=opteron -m64
```

```
CXXARCH_FLAGS= -march=opteron -m64
FARCH_FLAGS= -march=opteron -m64

########################################################################
# Portability Flags
########################################################################

255.vortex=default=default=default:
notes0045=   255.vortex=  CPORTABILITY=-DSPEC_CPU2000_LP64
CPORTABILITY      = -DSPEC_CPU2000_LP64

186.crafty=default=default=default:
notes0050=   186.crafty:  CPORTABILITY=-DLINUX_i386
CPORTABILITY      = -DLINUX_i386

252.eon=default=default=default:
notes0051=   252.eon:     CXXPORTABILITY=-DHAS_ERRLIST -DSPEC_CPU2000_LP64
CXXPORTABILITY  = -DHAS_ERRLIST -DSPEC_CPU2000_LP64

253.perlbmk=default=default=default:
notes0052=   253.perlbmk: CPORTABILITY=-DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL
notes0053=                -DSPEC_CPU2000_LP64
CPORTABILITY      = -DSPEC_CPU2000_NEED_BOOL -DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_LP64

254.gap=default=default=default:
notes0055=   254.gap:     CPORTABILITY=-DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO
notes0056=                -DSYS_HAS_CALLOC_PROTO -DSYS_HAS_MALLOC_PROTO
notes0057=                -DSPEC_CPU2000_LP64
CPORTABILITY      = -DSYS_HAS_MALLOC_PROTO -DSYS_HAS_CALLOC_PROTO -DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -
DSYS_HAS_TIME_PROTO -DSPEC_CPU2000_LP64

178.galgel=default=default=default:
notes0050=    178.galgel:     -ffixed-form
FPORTABILITY= -ffixed-form


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

#
# int2000
# Base tuning default optimization
#
int=base=gcc4-low-opt=default:
notes0080=  Baseline C:   gcc -O2
COPTIMIZE           = -O2

# High Optimization:
int=base=gcc4-high-opt=default:
notes0080=  Baseline C:   gcc -O3 ${CARCH_FLAGS}
notes0085=  Baseline C++: g++ -O3 ${CXXARCH_FLAGS}
COPTIMIZE           = -O3 ${CARCH_FLAGS}
PASS1_CFLAGS    = -fprofile-generate
PASS2_CFLAGS    = -fprofile-use
CXXOPTIMIZE       = -O3 ${CXXARCH_FLAGS}
PASS1_CXXFLAGS              = -fprofile-generate
PASS2_CXXFLAGS              = -fprofile-use


#
# fp2000
# Base tuning default optimization
#
#             Fortran benchmarks
#
fp=base=gcc4-low-opt=default:
notes0085=  Baseline: Fortran gfortran -O2
notes0080=  Baseline: C       gcc -O2
```

```
FOPTIMIZE           = -O2
F77OPTIMIZE         = -O2
COPTIMIZE           = -O2

#High Optimization:

fp=base=gcc4-high-opt=default:
notes0080=  Baseline: C       gcc      -O3 ${CARCH_FLAGS}
notes0085=  Baseline: Fortran gfortran -O3 ${FARCH_FLAGS}
COPTIMIZE           = -O3 ${CARCH_FLAGS}
PASS1_CFLAGS    = -fprofile-generate
PASS2_CFLAGS    = -fprofile-use
FOPTIMIZE           = -O3 ${FARCH_FLAGS}
PASS1_FFLAGS    = -fprofile-generate
PASS2_FFLAGS    = -fprofile-use


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

#
# int2000
# Peak tuning
#

int=peak=default=default:
notes0087=   All peak: basepeak=yes
basepeak = yes

#
# fp2000
# Peak tuning
#

fp=peak=default=default:
notes0087=   All peak: basepeak=yes
basepeak = yes


######################################################################
# Default Compiler Flags
######################################################################

int=default=default=default:
notes0030=  Portability:
sw_avail= June-2006
sw_compiler0000= GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
sw_compiler0001= GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)


fp=default=default=default:
sw_avail= June-2006
sw_compiler0000= GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
sw_compiler0001= GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
```

Appendix D – Configuration file for the Intel 9.1 C++/Fortran compiler on the Intel processor-based server

This appendix contains the benchmark configuration file we used to test the Dual-Core Intel Xeon Processor 5160-based server using the Intel 9.1 C/Fortran compiler.

```
# Invocation command line:
# /cpu2000/bin/runspec -c linux-woodcrest-intel9.1.cfg -T base -r -u 4 --reportable fp
############################################################################
action      = validate
tune        = base
ext         = cpu2000.v1.3.ic91p.woodcrest.sse3.linux64.em64t

check_md5=1
reportable=1

teeout=yes
teerunout=yes

default=default=default=default:
ONESTEP=YES
basepeak=yes
CC  = icc
CXX = icpc
F77 = ifort
FC  = ifort

default=default=default=default:
PORTABILITY = -DSPEC_CPU2000_LP64
notes002= -DSPEC_CPU2000_LP64 applied to all benchmarks

186.crafty=default=default=default:
CPORTABILITY=-DLINUX_i386
notes004= 186.crafty: -DLINUX_i386

252.eon=default=default=default:
CXXPORTABILITY=-DHAS_ERRLIST
notes005= 252.eon: -DHAS_ERRLIST

253.perlbmk=default=default=default:
CPORTABILITY=-DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -DSPEC_CPU2000_GLIBC22
notes006= 253.perlbmk: -DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -DSPEC_CPU2000_GLIBC22

254.gap=default=default=default:
CPORTABILITY=-DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -DSYS_HAS_SIGNAL_PROTO -
DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO
notes007= 254.gap: -DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -DSYS_HAS_SIGNAL_PROTO
notes008=          -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO

178.galgel=default=default=default:
EXTRA_FFLAGS = -FI
notes002: 178.galgel: -FI for fixed-format Fortran

int=base=default=default:
OPTIMIZE=
PASS1_CFLAGS= -fast -prof_gen -auto_ilp32
PASS2_CFLAGS= -fast -prof_use -auto_ilp32

notes001= Portability for integer benchmarks
notes010= Optimization flags
notes011= ONESTEP=yes for all benchmarks
notes012: +FDO implies feedback-directed optimization PASS1: -prof_gen   PAS2: -prof_use
notes013: Baseline optimizations for C:   -fast -auto_ilp32 +FDO
notes015: Baseline optimizations for C++: -fast -auto_ilp32 +FDO
notes016: basepeak=yes set for all benchmarks
```

252.eon=base=default=default:
OPTIMIZE=
PASS1_CXXFLAGS= -fast -prof_gen -auto_ilp32
PASS2_CXXFLAGS= -fast -prof_use -auto_ilp32

fp=base=default=default:
OPTIMIZE=
PASS1_CFLAGS= -fast -prof_gen
PASS2_CFLAGS= -fast -prof_use
PASS1_FFLAGS= -fast -prof_gen
PASS2_FFLAGS= -fast -prof_use

notes001= Portability for fp benchmarks
notes010= Optimization flags
notes011= ONESTEP=yes for all benchmarks
notes012: +FDO implies feedback-directed optimization PASS1: -prof_gen PAS2: -prof_use
notes013: Baseline optimizations for C and Fortran: -fast +FDO
notes014: basepeak=yes set for all benchmarks

##
Systsem config information
##

default=default=default=default:
hw_vendor= Intel
hw_model= Supermicro X7DB8 motherboard(3.0 GHz, Dual-Core Intel Xeon Processor 5160)
hw_cpu= Dual-Core Intel Xeon Processor 5160 (3.0GHz, 1333 MHz bus)
hw_cpu_mhz= 3000
hw_fpu= Integrated
hw_ncpu= 4 cores, 2 chips, 2 core/chip
hw_ncpuorder= 1,2
hw_parallel= No
hw_pcache= 32KBI + 32KBD on chip
hw_scache= 4MB (Shared)
hw_tcache= N/A
hw_ocache= N/A
hw_memory= 8 x 1GB, PC2-5300
hw_disk= SATA, 160 GB
hw_other= None
sw_os= Fedora Core 5
sw_file= ext3
sw_state= Multi-user Run level 3
company_name= Principled Technologies
license_num= 0
tester_name=
test_date=
hw_avail=
sw_avail=
prepared_by=
config=

##
Software information (Compilers and libraries)
##

int=default=default=default:
sw_compiler1=Intel C++ Compiler 9.1.038 for EM64T Build 20060323

fp=default=default=default:
sw_compiler1=Intel C++ Compiler 9.1.038 for EM64T Build 20060323
sw_compiler2=Intel Fortran Compiler 9.1.032 for EM64T Build 20060323

Appendix E – Configuration file for the Intel 9.1 C++/Fortran compiler on the AMD processor-based server

This appendix contains the configuration file we used to test the Dual-Core AMD Opteron 285-based server using the Intel 9.1 C/Fortran compiler.

```
# Invocation command line:
# /cpu2000/bin/runspec -c linux-opteron-intel9.1.cfg -T base -r -u 4 --reportable fp
############################################################################
action      = validate
tune        = base
ext         = cpu2000.v1.3.ic91p.opteron.sse2.linux64.em64t

check_md5=1
reportable=1

teeout=yes
teerunout=yes

default=default=default=default:
ONESTEP=YES
basepeak=yes
CC  = icc
CXX = icpc
F77 = ifort
FC  = ifort

default=default=default=default:
PORTABILITY = -DSPEC_CPU2000_LP64
notes002= -DSPEC_CPU2000_LP64 applied to all benchmarks

186.crafty=default=default=default:
CPORTABILITY=-DLINUX_i386
notes004= 186.crafty: -DLINUX_i386

252.eon=default=default=default:
CXXPORTABILITY=-DHAS_ERRLIST
notes005= 252.eon: -DHAS_ERRLIST

253.perlbmk=default=default=default:
CPORTABILITY=-DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -DSPEC_CPU2000_GLIBC22
notes006= 253.perlbmk: -DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -DSPEC_CPU2000_GLIBC22

254.gap=default=default=default:
CPORTABILITY=-DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -DSYS_HAS_SIGNAL_PROTO -
DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO
notes007= 254.gap: -DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -DSYS_HAS_SIGNAL_PROTO
notes008=          -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO

178.galgel=default=default=default:
EXTRA_FFLAGS = -FI
notes002: 178.galgel: -FI for fixed-format Fortran

int=base=default=default:
OPTIMIZE=
PASS1_CFLAGS= -O3 -ipo -no-prec-div -static -xW -prof_gen -auto_ilp32
PASS2_CFLAGS= -O3 -ipo -no-prec-div -static -xW -prof_use -auto_ilp32

notes001= Portability for integer benchmarks
notes010= Optimization flags
notes011= ONESTEP=yes for all benchmarks
notes012: +FDO implies feedback-directed optimization PASS1: -prof_gen   PAS2: -prof_use
notes013: Baseline optimizations for C:   -O3 -ipo -no-prec-div -static -xW -auto_ilp32 +FDO
notes015: Baseline optimizations for C++: -O3 -ipo -no-prec-div -static -xW -auto_ilp32 +FDO
notes016: basepeak=yes set for all benchmarks
```

252.eon=base=default=default:
OPTIMIZE=
PASS1_CXXFLAGS= -O3 -ipo -no-prec-div -static -xW -prof_gen -auto_ilp32
PASS2_CXXFLAGS= -O3 -ipo -no-prec-div -static -xW -prof_use -auto_ilp32

fp=base=default=default:
OPTIMIZE= -O3 -ipo -no-prec-div -static -xW
PASS1_CFLAGS= -prof_gen
PASS2_CFLAGS= -prof_use
PASS1_FFLAGS= -prof_gen
PASS2_FFLAGS= -prof_use

notes001= Portability for fp benchmarks
notes010= Optimization flags
notes011= ONESTEP=yes for all benchmarks
notes012: +FDO implies feedback-directed optimization PASS1: -prof_gen PASS2: -prof_use
notes013: Baseline optimizations for C and Fortran: -O3 -ipo -no-prec-div -static -xW +FDO
notes014: basepeak=yes set for all benchmarks

##
Systsem config information
##

default=default=default=default:
hw_vendor=   AMD
hw_model=   UNIWIDE Technologies SS232-128-03, AMD Opteron (TM) 285
hw_cpu=   Dual-Core AMD Opteron 285 (2.6 GHz, 2000 MHz HT)
hw_cpu_mhz=   2600
hw_fpu=   Integrated
hw_ncpu=   4 cores, 2 chips, 2 core/chip
hw_ncpuorder= 1,2
hw_parallel= No
hw_pcache=   64KBI + 64KBD on chip
hw_scache=   2MB (1MB per core)
hw_tcache=   N/A
hw_ocache=   N/A
hw_memory=   8 x 1GB, PC-3200
hw_disk=   SATA, 160 GB
hw_other=   None
sw_os=   Fedora Core 5
sw_file=   ext3
sw_state=   Multi-user Run level 3
company_name= Principled Technologies
license_num= 0
tester_name=
test_date=
hw_avail=
sw_avail=
prepared_by=
config=

##
Software information (Compilers and libraries)
##

int=default=default=default:
sw_compiler1=Intel C++ Compiler 9.1.038 for EM64T Build 20060323

fp=default=default=default:
sw_compiler1=Intel C++ Compiler 9.1.038 for EM64T Build 20060323
sw_compiler2=Intel Fortran Compiler 9.1.032 for EM64T Build 20060323

Appendix F – SPECfp_rate output

This appendix provides the output of the SPECfp_rate_base runs on both test servers with both compilers.

Dual-Core Intel Xeon Processor 5160-based server with gcc 4.1.1 compiler (4 users):

CFP2000 Result

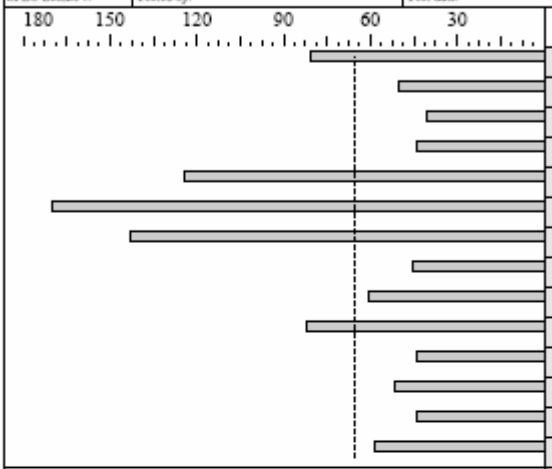
Intel

Supermicro X7DB8 motherboard(3.0 GHz, Dual-Core Intel Xeon Processor 5160)

SPECfp_rate2000 = --

SPECfp_rate_base2000 = 65.8

SPEC license # -- | Tested by: -- | Test date: -- | Hardware Avail: -- | Software Avail: June-2006



Benchmark	Base Copies	Base Runtime	Base Ratio	Copies	Runtime	Ratio
168.wupwise	4	91.9	80.8			
171.swim	4	287	50.2			
172.mgrid	4	207	40.3			
173.applu	4	223	43.7			
177.mesa	4	52.3	124			
178.galgel	4	79.3	170			
179.art	4	84.3	143			
183.equake	4	133	45.2			
187.facerec	4	146	60.5			
188.ammp	4	125	81.8			
189.lucas	4	212	43.8			
191.fma3d	4	188	51.9			
200.sixtrack	4	116	44.1			
301.apsi	4	205	58.8			

Hardware

CPU:	Dual-Core Intel Xeon Processor 5160 (3.0GHz, 1333 MHz bus)
CPU MHz:	3000
FPU:	Integrated
CPU(s) enabled:	4 cores, 2 chips, 2 core/chip
CPU(s) orderable:	1,2
Parallel:	No
Primary Cache:	32KBI + 32KBD on chip
Secondary Cache:	4MB (Shared)
L3 Cache:	N/A
Other Cache:	N/A
Memory:	8 x 1GB, PC2-5300
Disk Subsystem:	SATA, 160 GB
Other Hardware:	None

Software

Operating System:	Fedora Core 5
Compiler:	GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1) GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
File System:	Linux/ext3
System State:	Multi-user Run level 3

Notes/Tuning Information

```
Tested by Principled Technologies
    178.galgel:     -ffixed-form
  Baseline: C       gcc      -O3 -march=nocona -m64
  Baseline: Fortran gfortran -O3 -march=nocona -m64
   All peak: basepeak=yes
```

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

Dual-Core AMD Opteron 285-based server with gcc 4.1.1 compiler (4 users):

CFP2000 Result

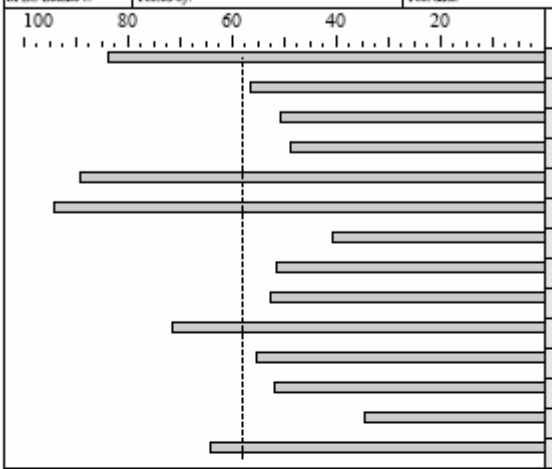
AMD

UNIWIDE Technologies SS232-128-03, AMD Opteron (TM) 285

SPECfp_rate2000 = --

SPECfp_rate_base2000 = 57.9

SPEC license # -- | Tested by: -- | Test date: -- | Hardware Avail: -- | Software Avail: June-2006



Benchmark	Base Copies	Base Runtime	Base Ratio	Copies	Runtime	Ratio
168.wupwise	4	88.7	83.7			
171.swim	4	255	56.5			
172.mgrid	4	165	50.5			
173.applu	4	201	48.5			
177.mesa	4	72.8	89.2			
178.galgel	4	143	94.0			
179.art	4	298	40.5			
183.equake	4	118	51.3			
187.facerec	4	167	52.6			
188.ammp	4	143	71.3			
189.lucas	4	168	55.2			
191.fma3d	4	188	51.9			
200.sixtrack	4	149	34.3			
301.apsi	4	188	64.1			

Hardware

CPU:	Dual-Core AMD Opteron 285 (2.6 GHz, 2000 MHz HT)
CPU MHz:	2600
FPU:	Integrated
CPU(s) enabled:	4 cores, 2 chips, 2 core/chip
CPU(s) orderable:	1,2
Parallel:	No
Primary Cache:	64KBI + 64KBD on chip
Secondary Cache:	2MB (1MB per core)
L3 Cache:	N/A
Other Cache:	N/A
Memory:	8 x 1GB, PC-3200
Disk Subsystem:	SATA, 160 GB
Other Hardware:	None

Software

Operating System:	Fedora Core 5
Compiler:	GNU gcc (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1) GNU Fortran 95 (GCC) 4.1.1 20060525 (Red Hat 4.1.1-1)
File System:	Linux/ext3
System State:	Multi-user Run level 3

Notes/Tuning Information

```
Tested by Principled Technologies
    178.galgel:     -ffixed-form
  Baseline: C       gcc      -O3 -march=opteron -m64
  Baseline: Fortran gfortran -O3 -march=opteron -m64
   All peak: basepeak=yes
```

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

Dual-Core Intel Xeon Processor 5160-based server with Intel C++/Fortran 9.1 compiler (4 users):

CFP2000 Result

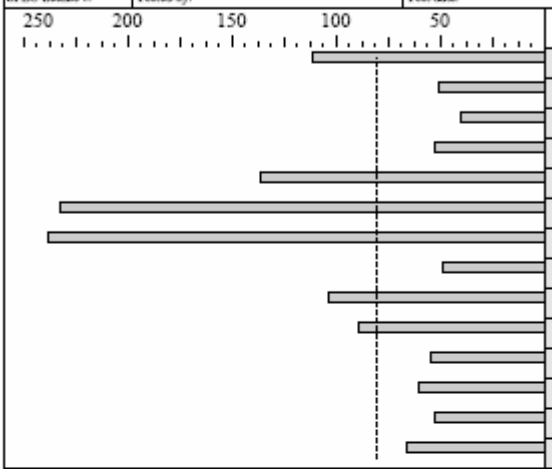
Intel

Supermicro X7DB8 motherboard(3.0 GHz, Dual-Core Intel Xeon Processor 5160)

SPECfp_rate2000 = --

SPECfp_rate_base2000 = 80.1

SPEC license # -- | Tested by: -- | Test date: -- | Hardware Avail: -- | Software Avail: June-2006



Benchmark	Base Copies	Base Runtime	Base Ratio	Copies	Runtime	Ratio
168.wupwise	4	66.9	111			
171.swim	4	283	50.9			
172.mgrid	4	207	40.3			
173.applu	4	187	52.1			
177.mesa	4	47.6	136			
178.galgel	4	57.9	232			
179.art	4	50.6	238			
183.equake	4	125	48.3			
187.facerec	4	85.4	103			
188.ammp	4	115	89.1			
189.lucas	4	170	54.7			
191.fma3d	4	161	60.4			
200.sixtrack	4	97.8	52.2			
301.apsi	4	184	65.6			

Hardware

CPU:	Dual-Core Intel Xeon Processor 5160 (3.0GHz, 1333 MHz bus)
CPU MHz:	3000
FPU:	Integrated
CPU(s) enabled:	4 cores, 2 chips, 2 core/chip
CPU(s) orderable:	1,2
Parallel:	No
Primary Cache:	32KBI + 32KBD on chip
Secondary Cache:	4MB (Shared)
L3 Cache:	N/A
Other Cache:	N/A
Memory:	8 x 1GB, PC2-5300
Disk Subsystem:	SATA, 160 GB
Other Hardware:	None

Software

Operating System:	Fedora Core 5
Compiler:	Intel C++ Compiler 9.1.038 for EM64T Build 20060823 Intel Fortran Compiler 9.1.032 for EM64T Build 20060823
File System:	Linux/ext3
System State:	Multi-user Run level 3

Notes/Tuning Information

```
Portability for fp benchmarks
-DSPEC_CPU2000_LP64 applied to all benchmarks
Optimization flags
ONESTEP-yes for all benchmarks
```

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

Dual-Core AMD Opteron 285-based server with Intel C++/Fortran 9.1 compiler (4 users):

CFP2000 Result

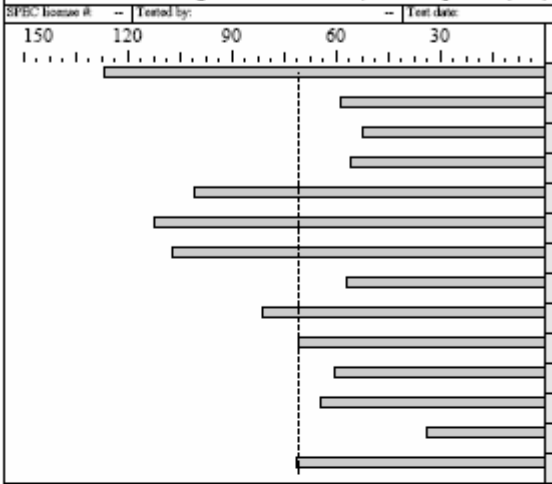
AMD

UNIWIDE Technologies SS232-128-03, AMD Opteron (TM) 285

SPECfp_rate2000 = --

SPECfp_rate_base2000 = 70.8

SPEC license # -- | Tested by: -- | Test date: -- | Hardware Avail: -- | Software Avail: June-2006



Benchmark	Base Copies	Base Runtime	Base Ratio	Copies	Runtime	Ratio
168.wupwise	4	58.6	127			
171.swim	4	245	58.7			
172.mgrid	4	159	52.4			
173.applu	4	175	55.7			
177.mesa	4	64.5	101			
178.galgel	4	120	112			
179.art	4	112	107			
183.equake	4	106	56.8			
187.facerec	4	109	81.0			
188.ammp	4	144	70.8			
189.lucas	4	154	60.3			
191.fma3d	4	152	64.3			
200.sixtrack	4	150	33.9			
301.apsi	4	170	71.0			

Hardware

CPU:	Dual-Core AMD Opteron 285 (2.6 GHz, 2000 MHz HT)
CPU MHz:	2600
FPU:	Integrated
CPU(s) enabled:	4 cores, 2 chips, 2 core/chip
CPU(s) orderable:	1,2
Parallel:	No
Primary Cache:	64KBI + 64KBD on chip
Secondary Cache:	2MB (1MB per core)
L3 Cache:	N/A
Other Cache:	N/A
Memory:	8 x 1GB, PC-3200
Disk Subsystem:	SATA, 160 GB
Other Hardware:	None

Software

Operating System:	Fedora Core 5
Compiler:	Intel C++ Compiler 9.1.038 for EM64T Build 20060823 Intel Fortran Compiler 9.1.032 for EM64T Build 20060823
File System:	Linux/ext3
System State:	Multi-user Run level 3

Notes/Tuning Information

```
Portability for fp benchmarks
-DSPEC_CPU2000_LP64 applied to all benchmarks
Optimization flags
ONESTEP-yes for all benchmarks
```

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

Principled Technologies, Inc.
4813 Emperor Blvd., Suite 100
Durham, NC 27703
www.principledtechnologies.com
info@principledtechnologies.com