VeriTest®

June 2003

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Apple Power Mac G5 CPU Performance Testing Using SPEC CPU2000

Test report prepared under contract from Apple Computer

Executive summary

Apple commissioned VeriTest, a division of Lionbridge Technologies Inc., to compare the performance of their prototype Power Mac G5 system to Dell Dimension 8300 and Dell Precision 650 systems using the SPEC CPU2000 benchmark suite. The goal of this test was to use the SPEC CPU2000 benchmark software to compare the relative performance of the three systems with similar operating system, memory and compiler configurations.

The SPEC CPU2000 benchmark suite is provided as source code for the tester to compile, the compiled code is then used to measure the performance of a system. To be able to directly compare the performance of the hardware systems, the same compiler - GCC, with similar settings were used on both platforms.

Key findings

- We found that the Power Mac G5 generated better SPECfp_base2000 test results compared to the Dell Dimension 8300 and Dell Precision 650 using our test configurations. Specifically, the Power Mac G5 generated a SPECfp_base2000 score of 840 compared to 693 for the Dell Dimension 8300 and 646 for the Dell Precision 650.
- We found that the Power Mac G5 generated better SPECfp_rate_base2000 test results compared to the Dell Dimension 8300 and Dell Precision 650 using our test configurations. Specifically, the Power Mac G5 generated a SPECfp_rate_base2000 score of 15.7 compared to 8.07 for the Dell Dimension 8300 and 11.1 for the Dell Precision 650.
- We found that the Power Mac G5 generated better SPECint_rate_base2000 test results compared to the Dell Dimension 8300 and the Dell Precision 650 using our test configurations. Specifically the PowerMac G5 generated a SPECint_rate_base2000 score of 17.2 compared to 16.7 for the Dell Precision 650 and 10.3 for the Dell Dimension 8300.

The PowerMac G5 was configured using MacOS X 10.2.7 (G5), GCC 3.3 (build 1379) and the NAGWare Fortran 95 compilers. The Dell systems were configured with Red Hat Linux 9.0 Professional, the GCC 3.3 and the NAGWare Fortran 95 compilers.

SPEC CPU2000 is a CPU-intensive benchmark suite designed to provide a comparative measure of compute intensive performance across a wide range of hardware configurations. These benchmarks measure the performance of the processor, memory and compiler on the tested system. SPEC CPU2000 consists of two components as follows:

- CINT2000 - measures and compares compute-intensive integer performance
- CFP2000 - measures and compares compute-intensive floating point performance.

The SPEC CPU2000 benchmarks allow users to conduct base and peak tests. Base tests are conducted using a maximum of four compiler flags used to improve overall performance. Peak tests allow users to find the absolute peak performance on a given configuration by allowing the user to specify any number of compiler flags when building the SPEC CPU2000 binaries. Each test produces an overall score that reflects the performance of the system under test compared to a baseline system. Higher numbers are better.

During testing, we ran the following series of base tests on the Apple Power Mac G5, Dell Dimension 8300 and the Dell Precision 650 systems described above. Please refer to Appendices of this report for complete disclosure information for all systems used in these tests. For more information reagrding the tests below, please refer to the Testing Methodology section of this report or go the SPEC.org Web site at http://www.spec.org/cpu2000.

- SPECint_base2000
- SPECint_rate_base2000
- SPECfp_base2000
- SPECfp_rate_base2000

Apple provided all the systems for the testing. Because the Power Mac G5 was still under development at the time we conducted the tests, a VeriTest analyst conducted all testing of the Apple Power Mac G5 system at the Apple facility in Cupertino, CA. Additionally, the same VeriTest analyst conducted the testing on the Dell Precision 650 system at the Apple facility in Cupertino, CA. All testing of the Dell Dimension 8300 system occurred in the VeriTest facility in Morrisville, NC.

At Apple's request, we configured the Dell Dimension 8300 and the Dell Precision 650 identically using Red Hat Linux 9.0 Professional, GCC version 3.3 and NAGWare Fortran 95 compiler Release 4.2(511). We worked with Apple engineers during the configuration of the Power Mac G5 and documented all operations performed to prepare the system for testing. Additionally, Apple provided the configuration files for all the SPEC CPU2000 testing on the Power Mac G5 system. Please refer to the Testing Methodology section and the Appendices of this report for complete details on the testing configurations.

Figure 1 shows the overall SPECint_base2000 and SPECfp_base2000 test results for all system configurations tested. In our test configurations, we found that the Power Mac G5 system delivered the best SPECfp_base2000 test results of 840 compared to 693 for the Dell Dimension 8300 and 646 for the Dell Precision 650. Additionally, we found that the Dell Dimension 8300 and the Dell Precision 650 delivered better SPECint_base2000 test results, 889 and 836 respectively, compared to 800 using the Power Mac G5 system. For these tests, higher scores are better.

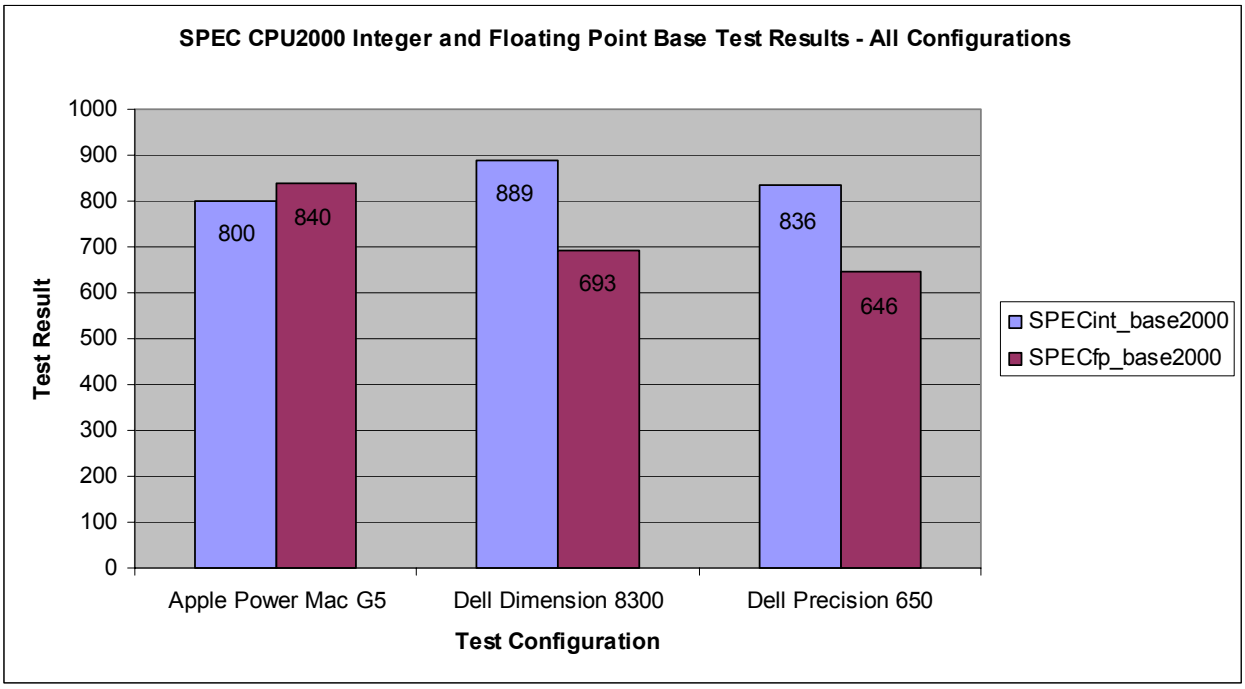

Figure 1. SPECint_base2000 and SPECfp_base2000 Test Results for all Configurations

Figure 2 shows the overall SPECint_rate_base2000 and SPECfp_rate_base2000 test results for all system configurations tested. In our test configurations, we found that the Power Mac G5 system delivered the best SPECfp_rate_base2000 test results of 15.7 compared to 8.07 for the Dell Dimension 8300 and 11.1 for the Dell Precision 650. Additionally, we found that the Power Mac G5 delivered the best SPECint_rate_base2000 test result of 17.2 compared to 16.7 using the Dell Precision 650 and 10.3 for the Dell Dimension 8300. For these tests, higher scores are better.

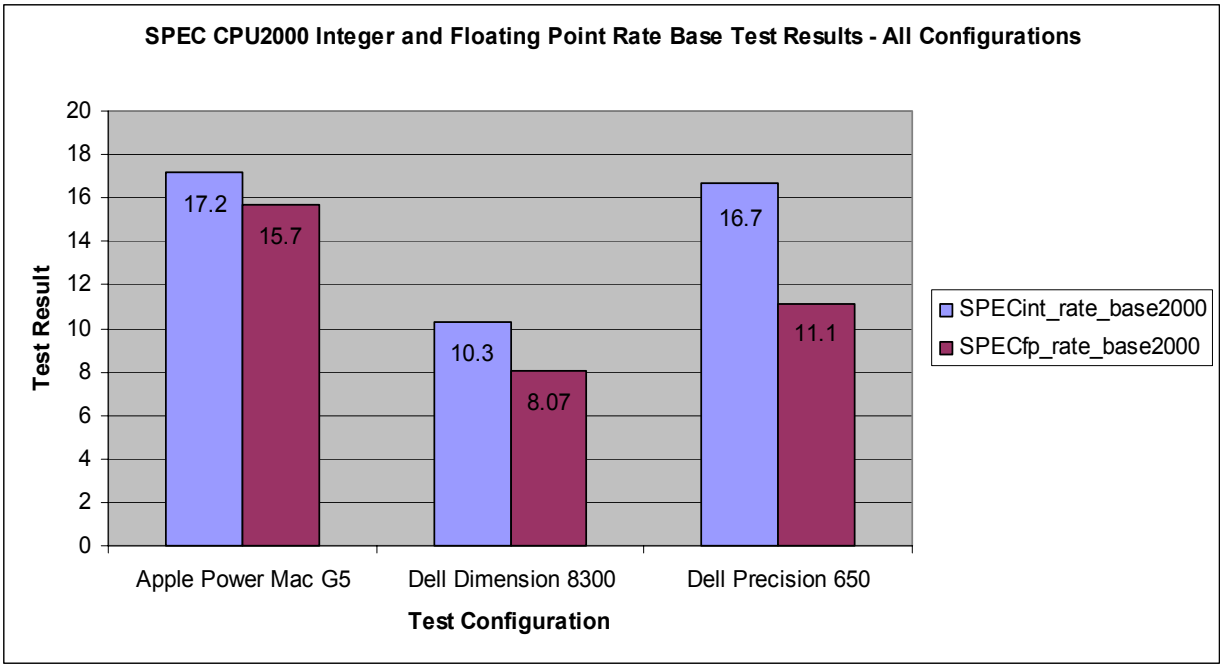

Figure 2. SPECint_rate_base2000 and SPECfp_rate_base2000 Test Results for all Configurations

Testing methodology

Apple commissioned VeriTest, a division of Lionbridge Technologies Inc., to compare the performance of their prototype Power Mac G5 system to Dell Dimension 8300 and Dell Precision 650 systems configured with Red Hat Linux 9.0 Professional, the GCC 3.3 and NAGWare Fortran 95 compilers using the SPEC CPU2000 v 1.2 integer and floating point benchmarks.

The goal of this test was to use the SPEC CPU2000 benchmark software to compare the relative performance of the three systems with similar operating system, memory and compiler configurations.

The SPEC CPU2000 benchmark suite is provided as source code for the tester to compile, the compiled code is then used to measure the performance of a system. To be able to directly compare the performance of the hardware systems, the same compiler - GCC, with similar settings were used on both platforms.

The PowerMac G5 was configured using MacOS X 10.2.7 (G5), GCC 3.3 (build 1379) and the NAGWare Fortran 95 compilers. The Dell systems were configured with Red Hat Linux 9.0 Professional, the GCC 3.3 and the NAGWare Fortran 95 compilers.

SPEC CPU2000 is a CPU-intensive benchmark suite designed to provide a comparative measure of compute intensive performance across a wide range of hardware configurations. These benchmarks measure the performance of the processor, memory and compiler on the tested system. SPEC CPU2000 consists of two components as follows:

- CINT2000 - measures and compares compute-intensive integer performance

- CFP2000 - measures and compares compute-intensive floating point performance.

The SPEC CPU2000 benchmarks allow users to conduct base and peak tests. Base tests allow a maximum of four compiler flags to improve overall performance. Peak tests allow user to find the absolute peak performance on a given configuration by allowing the user to specify any number of compiler flags when building the SPEC CPU2000 binaries.

During testing, we ran the following series of base tests on the Apple Power Mac G5, Dell Dimension 8300 and the Dell Precision 650 systems described above. For all the tests above, higher scores are better.

- SPECint_base2000
- SPECint_rate_base2000
- SPECfp_base2000
- SPECfp_rate_base2000

The SPECint_rate_base2000 and the SPECfp_rate_base2000 tests measure the throughput or rate at which a system under test can complete a number of tasks in a specific time frame. For these tests, multiple copies of the benchmarks are run simultaneously and the number of copies run is generally, but not required, to be the same as the number of processors in the system.

The SPECint_base2000 and the SPECfp_base 2000 tests measure the speed with which the system under test completes a number of tasks.

SPEC® and SPEC CPU2000® are registered trademarks of the Standard Performance Evaluation Corporation. For the latest SPEC CPU2000 benchmark results or additional information regarding the SPEC CPU2000 tests, please refer to the SPEC Web site at:

http://www.spec.org/cpu2000/

To generate publishable test results using the SPEC CPU2000 benchmarks, SPEC sets forth a number of run and reporting rules that must be followed by users of the benchmark. These rules generally deal with the number of compiler options allowed for specific tests (base tests versus peak tests) and the level of detail required when disclosing the specifics of the tested configurations. The specific run and reporting rules for SPEC CPU2000 can be found at the following locations on the SPEC Web site:

http://www.spec.org/cpu2000/docs/runrules.html

For all tests, we followed the run and reporting rules for the base tests. Please refer to the Appendices of this test report for complete details of the system configurations used during these tests, the SPEC CPU2000 configuration files and compiler flag explanations used for these tests.

Apple provided all the systems for the testing. Because the Power Mac G5 was still under development at the time we conducted the tests, a VeriTest analyst conducted all testing of the Apple Power Mac G5 system at the Apple facility in Cupertino, CA. Additionally, the same VeriTest analyst conducted the testing on the Dell Precision 650 system at the Apple facility in Cupertino, CA. All testing of the Dell Dimension 8300 system occurred in the VeriTest facility in Morrisville, NC.

We configured the Dell Dimension 8300 and the Dell Precision 650 identically using Red Hat Linux 9.0 Professional, GCC version 3.3 and NAGWare Fortran 95 compiler Release 4.2(511). We worked with Apple engineers during the configuration of the Power Mac G5 and documented all operations performed to prepare the system for testing. The following sections provide the details of the system configurations used during these tests.

Configuring and Testing the Power Mac G5 System

This section describes the details of the steps taken to configure and test the Apple Power Mac G5 system. An Apple engineer conducted the configuration and setup while a VeriTest analyst recorded the information and verified the configuration. The Power Mac G5 system tested contained two IBM PowerPC G5 processors, 512KB of L2 cache and 1.5 GB of RAM.

Initial Power Mac G5 Configuration for all SPEC CPU2000 Testing

The following items were initially performed on the Apple Power Mac G5 system before starting the testing. The configuration described below was used for all SPEC CPU2000 testing.

- Installed BootROM version 5.0.0b5
- Installed Mac OS X version 10.2.7 build 6S43
- Installed theTachyon development environment version 6K452. This provides the appropriate development tools for generating the SPEC binaries and installs Apple's version of the GCC compiler (version 3.3 build 1379) on the test system
- Install the NAGWare Fortran 95 compiler 4.2(500). This is required to build the SPEC binary files for the SPECfp_base and SPECfp_rate_base testing.
- Install the Computer Hardware Understanding Development kit (CHUD) version 3.0.0b19. This tool is designed to simplify performance studies of PowerPC Macintosh systems running Mac OS X by providing a set of tools for developers to analyze their applications. CHUD will be available for download after June 23, 2003 at to http://developer.apple.com/tools/performance.
- Using the "Reggie" tool available from CHUD, modify CPU registers to enable memory Read By-pass. As Read requests are speculatively sent to the memory controller, this eliminates the need to wait for the snoop response required in a multiprocessor configuration thus reducing the time required for a read request.
- Used the command "hwprefetch -8" to enable the maximum of eight hardware pre-fetch streams and disable software-based pre-fetching.
- Installed a high performance, single threaded malloc library. This library implementation is geared for speed rather than memory efficiency and is single-threaded which makes it unsuitable for many uses. Special provisions are made for very small allocations (less than 4 bytes). This library is accessed through use of the –lstmalloc flag during program linking.

Power Mac G5 Configuration for SPEC CPU2000 Rate Base Testing

We verified that the following items were performed before starting the SPEC CPU2000 Rate Base testing which included the SPECint_rate_base2000 and SPECfp_rate_base2000 testing.

- Reboot the system
- Verified that both processors were in the system under test
- Turn off Screen Saver by opening "/Application/System Preferences", clicking on "Screen Effects", selecting the tab "Activation" and dragging the slider to "Never".
- Turn off Energy Saver by opening "/Application/System Preferences", clicking on "Energy Saver", selecting the tab "Sleep", dragging all the sliders to "Never" and unchecking "Put the hard disk to sleep when possible".
- Turn off Sharing by opening "/Application/System Preferences", clicking on "Sharing", selecting the tab "Service" and unchecking all services.
- Turn off Software Update functions by opening "/Application/System Preferences", clicking on "Software Update" and unchecking the item "Automatically check for updates when you have a network connection"

- Turn off Network Time synchronization by opening "/Application/System Preferences", clicking on “Date & Time”, selecting the tab “Network Time” and unchecking “Use network time server”.
- Turn off CUPS support by modifying the file /etc/hostconfig as root and changing the entry "CUPS=-YES-" to "CUPS=-NO-".
- Reboot the system
- On system restart, log in as console using >console as the username. Logging in as >console prevents the Window Manager from running.
- Run the benchmarks.

Power Mac G5 Configuration for SPEC CPU2000 Base Testing

We verified that the following items were performed before starting the SPEC CPU2000 Base testing which included the SPECint_base2000 and SPECfp_base2000 testing.

- Physically removed one of the processors from the system under test
- Reboot the system
- Turn off Screen Saver by opening "/Application/System Preferences", clicking on "Screen Effects", selecting the tab "Activation" and dragging the slider to "Never".
- Turn off Energy Saver by opening "/Application/System Preferences", clicking on "Energy Saver", selecting the tab "Sleep", dragging all the sliders to "Never" and unchecking "Put the hard disk to sleep when possible".
- Turn off Sharing by opening "/Application/System Preferences", clicking on "Sharing", selecting the tab "Service" and unchecking all services.
- Turn off Software Update functions by opening "/Application/System Preferences", clicking on “Software Update" and unchecking the item "Automatically check for updates when you have a network connection”
- Turn off Network Time synchronization by opening "/Application/System Preferences", clicking on “Date & Time”, selecting the tab “Network Time” and unchecking “Use network time server”.
- Turn off CUPS support by modifying the file /etc/hostconfig as root and changing the entry "CUPS=-YES-" to "CUPS=-NO-".
- Reboot the system
- On system restart, log in as console using >console as the username. Logging in as >console prevents the Window Manager from running.
- Run the benchmarks.

Apple provided the SPEC CPU2000 configuration file used when testing the Apple Power Mac G5 system using both the integer and floating point tests. This configuration file is shown in Appendix C of this report.

Configuring the Dell Dimension 8300 System

This section describes the details of the steps taken to configure the Dell Dimension 8300 for the SPEC CPU2000 testing. We conducted the configuration and testing of the Dell Dimension 8300 system in our facility in RTP, NC. The specifics of this configuration are as follows:

Dell Dimension 8300 Configuration for all SPEC CPU2000 Testing

The following items were initially performed on the Dell Dimension 8300 system before starting the testing. This system contained one Pentium 4 processor running at 3.0 GHz, 512K L2 cache and 2GB of RAM. The configuration described below was used for all SPEC CPU2000 testing.

- Installed a retail, shrink wrapped version of Red Hat Linux 9.0 Professional by selecting the standard “Workstation” option during the installation process.
- Installed the compat-db-3.3.11-4.i386.rpm package from the RedHat CDs to install libdbso.3. This was required to get the SPEC CPU2000 binaries to build correctly.
- Downloaded GCC version 3.3 (gcc-3.3.tar.gz) from http://gcc.gnu.org.
- Followed the documented steps to build and installed GCC v 3.3 on the system.
- Downloaded a 30-day trial version of the NAGWare Fortran 95 version 4.2(511) compiler from http://wwhw.nag.com/nagware/NP/NP_trial.asp.
- Installed the NAGWare Fortran 95 compiler using default options by following the instructions provided with the software. This is required to build the SPEC binary files for the SPECfp_base2000 and SPECfp_rate_base2000 testing.
- Installed SPEC CPU2000 v 1.2 following the standard installation instructions in the SPEC CPU2000 documentation.

Dell Dimension 8300 Configuration for SPEC CPU2000 Base Testing

We performed the following items before starting the SPEC CPU2000 Base testing which included the SPECint_base2000 and SPECfp_base2000 testing.

- Use the system setup utility to enable hyperthreading in the system
- Reboot the system and select the SMP kernel built during installation of Red Hat Linux 9.0 Professional (2.4.20-18.9smp)
- Using the “services” utility available in Red Hat Linux 9.0 Professional, edit the list of services started with run level 3 to ensure that the CUPS, SSH and SENDMAIL services do not start when entering run level 3.
- Set the system to run level 3 using the “init 3” command. This run level does not provide the Window Management and X server functionality.
- Run the benchmarks.

Dell Dimension 8300 Configuration for SPEC CPU2000 Rate Base Testing

We performed the following items before starting the SPEC CPU2000 Rate Base testing which included the SPECint_rate_base2000 and SPECfp_rate_base2000 testing.

- Use the system setup utility to disable hyperthreading in the system.
- Reboot the system selecting the uni-processor kernel built during installation of Red Hat Linux 9.0 Professional (2.4.20-18.9)
- Using the “services” utility available in Red Hat Linux 9.0 Professional, edit the list of services started with run level 3 to ensure that the CUPS, SSH and SENDMAIL services do not start when entering run level 3.
- Set the system to run level 3 using the “init 3” command. This run level does not provide the Window Management and X server functionality.
- Run the benchmarks

For the testing using the Dell systems, we started with the SPEC CPU2000 configuration file for Linux provided with the CPU2000 software. We investigated a number of performance tuning options available for the GCC and NAGWare compilers**.** The final compiler options used for the SPEC CPU2000 testing with the Dell Dimension 8300 are listed in the configuration files located in the Appendix B of this report.

Configuring the Dell Precision 650 system

This section describes the details of the steps taken to configure the Dell Precision 650 systems used during these tests. A VeriTest analyst conducted the configuration and testing of the Dell Precision 650 system on site at Apple’s facility in Cupertino CA. The specifics of this configuration is as follows:

Initial Dell Precision 650 Configuration for all SPEC CPU2000 Testing

The following items were initially performed on the Dell Precision 650 system before starting the testing. This system contained two Pentium 4 Xeon processors running at a speed of 3.06 GHz, 512K L2 cache and 2GB of RAM. The configuration described below was used for all SPEC CPU2000 testing.

- Installed a retail, shrink wrapped version of Red Hat Linux 9.0 Professional by selecting the standard "Workstation" option during the installation process.
- Installed the compat-db-3.3.11-4.i386.rpm package from the RedHat CDs to install libdbso.3. This was required to get the SPEC CPU2000 binaries to build correctly.
- Downloaded GCC version 3.3 (gcc-3.3.tar.gz) from http://gcc.gnu.org.
- Installed GCC v 3.3 on the system.
- Downloaded a 30-day trial version of the NAGWare Fortran 95 compiler version 4.2(511) from http://wwhw.nag.com/nagware/NP/NP_trial.asp.
- Installed the NAGWare Fortran 95 compiler using default options by following the instructions provided with the software. This is required to build the SPEC binary files for the SPECfp_base2000 and SPECfp_rate_base2000 testing.
- Installed SPEC CPU2000 v 1.2 following the standard installation instructions in the SPEC CPU2000 documentation.

Dell Precision 650 Configuration for SPEC CPU2000 Base Testing

We performed the following items before starting the SPEC CPU2000 Base testing which included the SPECint_base2000 and SPECfp_base2000 testing.

- Use the system setup utility to disable the second processor in the system
- Use the system setup utility to enable hyperthreading in the system
- Reboot the system and select the SMP kernel built during installation of Red Hat Linux 9.0 Professional (2.4.20-18.9smp)
- Using the "services" utility available in Red Hat Linux 9.0 Professional, edited the list of services started with run level 3 to ensure that the CUPS, SSH and SENDMAIL services do not start when entering run level 3.
- Set the system to run level 3 using the "init 3" command. This run level does not provide the Window Management and X server functionality.
- Run the benchmarks.

Dell Precision 650 Configuration for SPEC CPU2000 Rate Base Testing

We performed the following items before starting the SPEC CPU2000 Base testing which included the SPECint_rate_base2000 and SPECfp_rate_base2000 testing.

- Use the system setup utility to enable the second system processor
- Use the system setup utility to disable hyperthreading in the system
- Reboot the system and select the SMP kernel built during installation of Red Hat Linux 9.0 Professional (2.4.20-18.9smp)
- Using the "services" utility available in Red Hat Linux 9.0 Professional, edited the list of services started with run level 3 to ensure that the CUPS, SSH and SENDMAIL services do not start when entering run level 3.
- Set the system to run level 3 using the "init 3" command. This run level does not provide the Window Management and X server functionality.
- Run the benchmarks.

Test results

This section provides the details of the testing we conducted. Please refer to the Testing Methodology section of this report for complete details on how we conducted these tests. Please refer to the Appendices of this report for the complete SPEC configuration files used for these tests.

SPEC CPU2000 Base Performance Test Results

Figure 3 shows the overall SPECint_base2000 and SPECfp_base2000 test results for all system configurations tested. In our test configurations, we found that the Power Mac G5 system delivered the best SPECfp_base2000 test results of 840 compared to 693 for the Dell Dimension 8300 and 646 for the Dell Precision 650. Additionally, we found that the Dell Dimension 8300 and the Dell Precision 650 delivered better SPECint_base2000 test results, 889 and 836 respectively, compared to 800 using the Power Mac G5 system. For these tests, higher scores are better.

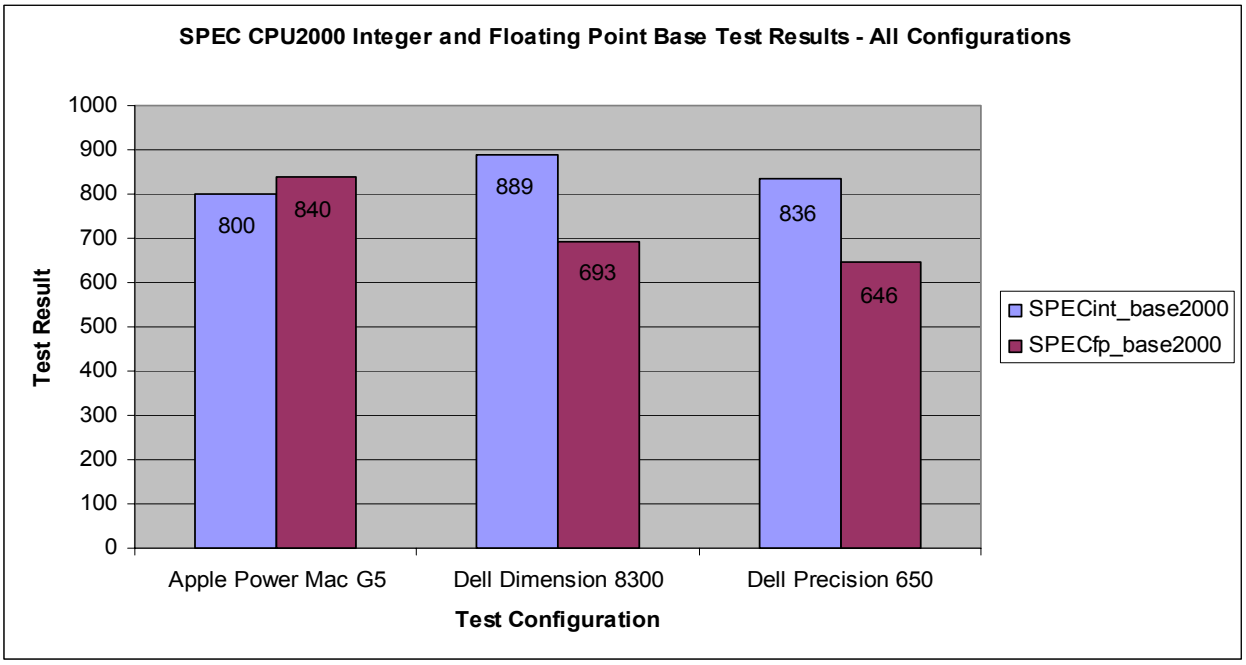

Figure 3. SPECint_base2000 and SPECfp_base2000 Test Results for all Configurations

Figures 4 - 6 show the complete set of benchmark scores generated during the SPECint_base2000 testing for all configurations tested. Figures 7 – 9 show the complete set of benchmark scores generated during the SPECfp_base2000 testing for all configurations tested. These results were taken directly from the SPEC generated test results files.

Benchmark	Reference Time	Base Runtime	Base Ratio
164.gzip	1400	180	779
175.vpr	1400	259	541
176.gcc	1100	106	1038
181.mcf	1800	340	530
186.crafty	1000	94.8	1055
197.parser	1800	310	581
252.eon	1300	104	1251

253.perlbmk	1800	201	896
254.gap	1100	126	874
255.vortex	1900	154	1231
256.bzip2	1500	228	659
300.twolf	3000	490	612
SPECint_base2000			**800**

Figure 4. SPECint_base2000 test results for Apple Power Mac G5

Benchmark	Reference Time	Base Runtime	Base Ratio
164.gzip	1400	154	910
175.vpr	1400	233	601
176.gcc	1100	104	1055
181.mcf	1800	260	693
186.crafty	1000	103	969
197.parser	1800	211	855
252.eon	1300	156	833
253.perlbmk	1800	151	1195
254.gap	1100	108	1021
255.vortex	1900	161	1180
256.bzip2	1500	191	785
300.twolf	3000	384	781
SPECint_base2000			**889**

Figure 5. SPECint_base2000 test results for Dell Dimension 8300

Benchmark	Reference Time	Base Runtime	Base Ratio
164.gzip	1400	152	920
175.vpr	1400	265	528
176.gcc	1100	112	978
181.mcf	1800	313	575
186.crafty	1000	102	978
197.parser	1800	218	827
252.eon	1300	156	834
253.perlbmk	1800	151	1194
254.gap	1100	113	975
255.vortex	1900	167	1140
256.bzip2	1500	217	692
300.twolf	3000	438	685
SPECint_base2000			**836**

Figure 6. SPECint_base2000 test results for Dell Precision 650

Benchmark	Reference Time	Base Runtime	Base Ratio
168.wupwise	1600	161	994
171.swim	3100	212	1465
172.mgrid	1800	284	634
173.applu	2100	307	683
177.mesa	1400	123	1137
178.galgel	2900	262	1105
179.art	2600	379	686
183.equake	1300	131	991
187.facerec	1900	160	1191
188.ammp	2200	464	474
189.lucas	2000	216	925
191.fma3d	2100	219	957
200.sixtrack	1100	189	582
301.apsi	2600	466	558
SPECfp_base2000			**840**

Figure 7. SPECfp_base2000 test results for Apple Power Mac G5

Benchmark	Reference Time	Base Runtime	Base Ratio
168.wupwise	1600	226	709
171.swim	3100	392	790
172.mgrid	1800	339	530
173.applu	2100	261	806
177.mesa	1400	131	1067
178.galgel	2900	262	1107
179.art	2600	431	603
183.equake	1300	113	1155
187.facerec	1900	300	634
188.ammp	2200	423	519
189.lucas	2000	221	904
191.fma3d	2100	470	447
200.sixtrack	1100	297	370
301.apsi	2600	427	609
SPECfp_base2000			**693**

Figure 8. SPECfp_base2000 test results for Dell Dimension 8300

Benchmark	Reference Time	Base Runtime	Base Ratio
168.wupwise	1600	230	696
171.swim	3100	457	678
172.mgrid	1800	352	512
173.applu	2100	296	711
177.mesa	1400	132	1061
178.galgel	2900	281	1032
179.art	2600	465	559
183.equake	1300	125	1043
187.facerec	1900	314	605

188.ammp	2200	465	474
189.lucas	2000	260	768
191.fma3d	2100	474	443
200.sixtrack	1100	290	379
301.apsi	2600	477	545
SPECfp_base2000			**646**

Figure 9. SPECfp_base2000 test results for Dell Precision 650

SPEC CPU2000 Rate Base Performance Test Results

Figure 10 shows the overall SPECint_rate_base2000 and SPECfp_rate_base2000 test results for all system configurations tested. In our test configurations, we found that the Power Mac G5 system delivered the best SPECfp_rate_base2000 test results of 15.7 compared to 8.07 for the Dell Dimension 8300 and 11.1 for the Dell Precision 650. Additionally, we found that the Power Mac G5 delivered the best SPECint_rate_base2000 test result of 17.2 compared to 16.7 using the Dell Precision 650 and 10.3 for the Dell Dimension 8300. For these tests, higher scores are better.

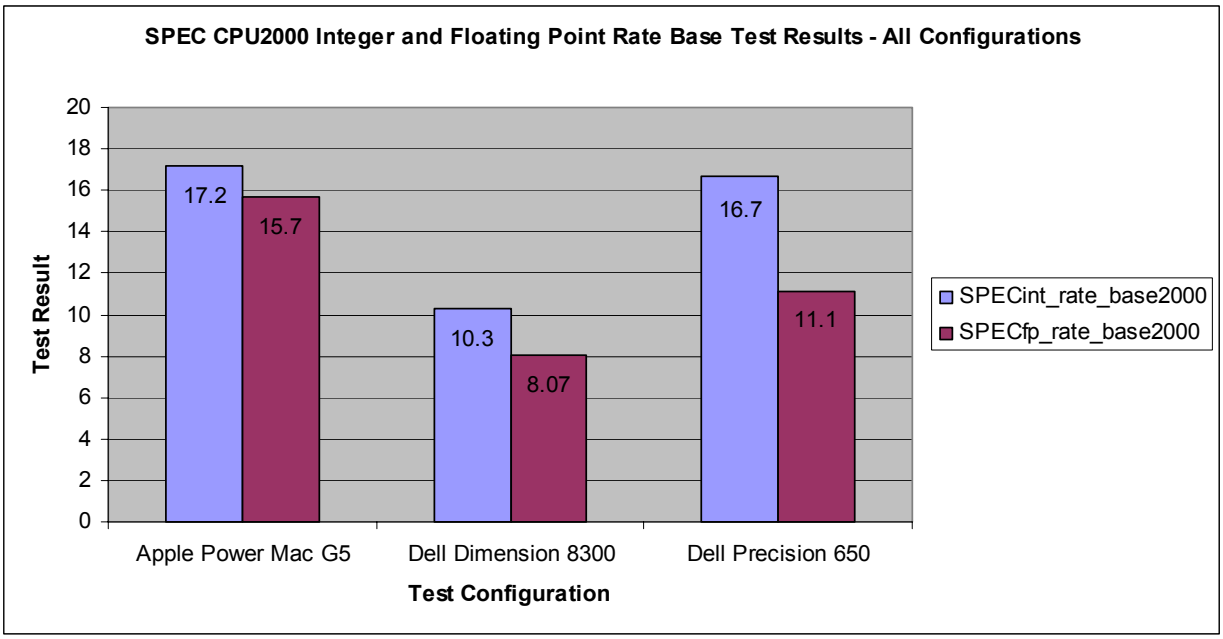

Figure 10. SPECint_rate_base2000 and SPECfp_rate_base2000 Test Results for all Configurations

Figures 11 – 13 show the complete set of benchmark scores generated during the SPECint_rate_base2000 and SPECint_rate_base2000 testing for all configurations tested. Figures 14 - 16 show the complete set of benchmark scores generated during the SPECfp_rate_base2000 testing for all configurations tested. These results were taken directly from the SPEC generated test results files.

Benchmark	Base Copies	Base Runtime	Base Ratio
164.gzip	2	185	17.5
175.vpr	2	295	11
176.gcc	2	127	20.1
181.mcf	2	436	9.58
186.crafty	2	94.3	24.6
197.parser	2	318	13.1

252.eon	2	103	29.2
253.perlbmk	2	202	20.7
254.gap	2	132	19.3
255.vortex	2	157	28
256.bzip2	2	259	13.4
300.twolf	2	538	12.9
SPECint_rate_base2000			**17.2**

Figure 11. SPECint_rate_base2000 test results for Apple Power Mac G5

Benchmark	Base Copies	Base Runtime	Base Ratio
164.gzip	1	153	10.6
175.vpr	1	232	7.00
176.gcc	1	103	12.4
181.mcf	1	261	8.00
186.crafty	1	103	11.2
197.parser	1	210	9.93
252.eon	1	157	9.62
253.perlbmk	1	149	14
254.gap	1	107	11.9
255.vortex	1	161	13.7
256.bzip2	1	193	9.03
300.twolf	1	384	9.06
SPECint_rate_base2000			**10.3**

Figure 12. SPECint_rate_base2000 test results for the Dell Dimension 8300

Benchmark	Base Copies	Base Runtime	Base Ratio
164.gzip	2	154	21.1
175.vpr	2	342	9.49
176.gcc	2	141	18.1
181.mcf	2	549	7.61
186.crafty	2	104	22.3
197.parser	2	233	17.9
252.eon	2	156	19.3
253.perlbmk	2	154	27
254.gap	2	119	21.5
255.vortex	2	175	25.2
256.bzip2	2	284	12.2
300.twolf	2	565	12.3
SPECint_rate_base2000			**16.7**

Figure 13. SPECint_rate_base2000 test results for the Dell Precision 650

Benchmark	Base Copies	Base Runtime	Base Ratio
168.wupwise	2	169	22
171.swim	2	395	18.2
172.mgrid	2	330	12.6
173.applu	2	363	13.4
177.mesa	2	123	26.4

178.galgel	2	304	22.1
179.art	2	668	9.03*
183.equake	2	166	18.2
187.facerec	2	209	21.1
188.ammp	2	533	9.58*
189.lucas	2	323	14.4
191.fma3d	2	267	18.2
200.sixtrack	2	188	13.6
301.apsi	2	524	11.5
SPECfp_rate_base2000			**15.7**

Figure 14. SPECfp_rate_base2000 test results for Apple Power Mac G5

Benchmark	Base Copies	Base Runtime	Base Ratio
168.wupwise	1	222	8.35
171.swim	1	393	9.15
172.mgrid	1	339	6.16
173.applu	1	261	9.33
177.mesa	1	133	12.2
178.galgel	1	262	12.8
179.art	1	432	6.98
183.equake	1	112	13.5
187.facerec	1	300	7.36
188.ammp	1	425	6.00
189.lucas	1	216	10.7
191.fma3d	1	470	5.18
200.sixtrack	1	291	4.39
301.apsi	1	426	7.09
SPECfp_rate_base2000			**8.07**

Figure 15. SPECfp_rate_base2000 test results for the Dell Dimension 8300

Benchmark	Base Copies	Base Runtime	Base Ratio
168.wupwise	2	241	15.4
171.swim	2	1211	5.94
172.mgrid	2	442	9.45
173.applu	2	422	11.5
177.mesa	2	133	24.4
178.galgel	2	367	18.4
179.art	2	910	6.63
183.equake	2	196	15.4
187.facerec	2	338	13
188.ammp	2	579	8.81
189.lucas	2	417	11.1
191.fma3d	2	485	10
200.sixtrack	2	307	8.31
301.apsi	2	646	9.33
SPECfp_rate_base2000			**11.1**

Figure 16. SPECfp_rate_base2000 test results for the Dell Precision 650

Appendix A – Equipment Disclosure

Apple Power Mac G5	
Machine Type	Power Mac G5 Dual 2.0 GHz
Processors	PowerPC G5
Primary Cache	64KBI+32KBD
Secondary Cache	512KB I+D (Onchip)
L3 Cache	N/A
Other Cache	N/A
Memory	1.5GB
Disk(s)	Seagate Barracuda 120 GB Serial ATA, 7200 RPM
Parallel	No
OS	Mac OS X 10.2.7 (6S43)
FPU	Integrated
CPU(s) Enabled	2
CPU(s) Orderable	2
Other Hardware	SuperDrive CD, ATI Radeon 9600 (64MB) Video
'C' Compiler	Apple GCC 3.3 (1364)
Fortran Compiler	NAGWare F95 Rel. 4.2(500)
File System	HFS+

Figure 17. System Disclosure for Apple Power Mac G5 system

Dell Dimension 8300	
Machine Type	Dell Dimension 8300
Processors	Pentium 4 3.0 Ghz Hyperthreaded, 800Mhz Front Side Bus, Intel 875P Chipset
Primary Cache	12k micro-ops I + 8KBD on chip
Secondary Cache	512KB(I+D) on chip
L3 Cache	N/A
Other Cache	N/A
Memory	2048 MB
Disk(s)	1 x 200GB 7200 RPM IDE
Parallel	No
OS	Red Hat Linux 9.0 Professional
FPU	Integrated
CPU(s) Enabled	1
CPU(s) Orderable	1
Other Hardware	SuperDrive CD, ATI Radeon 9800 Pro (128MB DDR) Video
'C' Compiler	FSF GCC 3.3
Fortran Compiler	NAGWare F95 Rel. 4.2(511)
File System	Ext3

Figure 18: System Disclosure for Dell Dimension 8300 system

Dell Precision 650	
Machine Type	Dell Precision 650
Processors	2 x Pentium 4 XEON, 3.06 GHz, 533MHz Front Side Bus
Primary Cache	12k micro-ops I + 8KBD on chip
Secondary Cache	512KB(I+D) on chip
L3 Cache	N/A
Other Cache	N/A
Memory	2048 MB
Disk(s)	1 x 120GB 7200 RPM Ultra ATA/100
Parallel	No
OS	Red Hat Linux 9.0 Professional
FPU	Integrated
CPU(s) Enabled	2
CPU(s) Orderable	2
Other Hardware	No
'C' Compiler	FSF GCC 3.3
Fortran Compiler	NAGWare F95 Rel. 4.2(511)
File System	Ext3

Figure 19. System Disclosure for Dell Precision 650 system

Appendix B. Dell Precision 650 SPEC CPU2000 configuration file

This section provides the configuration file used when conducting the SPEC CPU2000 testing on the Dell Precision 650 systems

```
# FSF_f95.cfg
#
# This config file is for the FSF gcc compiler with the NAG Fortran 95 compiler
#
action        = validate
tune          = base
ext           = FSF_f95
runlist       = all
output_format = all
feedback      = 1

teeout        = 1
teerunout     = 1

# Compilers
default=default=default=default:
CC=gcc
CXX=g++
FC=f95

# Optimization Flags
default=default=default=default:
CXXOPTIMIZE = -O3 -march=pentium4 -mfpmath=sse
COPTIMIZE = -O3 -march=pentium4 -mfpmath=sse
```

```
FOPTIMIZE = -O3 -Wc,-march=pentium4,-mfpmath=sse

# FDO Flags
default=default=default=default:
fdo_pre0 = rm -rf *.da
PASS1_CFLAGS = -fprofile-arcs
PASS1_CXXFLAGS = -fprofile-arcs
PASS1_FFLAGS = -Wc,-fprofile-arcs
PASS2_CFLAGS = -fbranch-probabilities
PASS2_CXXFLAGS = -fbranch-probabilities
PASS2_FFLAGS = -Wc,-fbranch-probabilities

default=default=default=default:
hw_vendor   = Intel
hw_model    = E7505
hw_cpu      = Pentium 4 Xeon
hw_cpu_mhz  = 3.06GHz (533 FSB)
hw_fpu      = yes
hw_ncpu     = 1
hw_ncpuorder= 1
hw_parallel = no
hw_pcache   = 8KB-D 12KB-I on chip
hw_scache   = 512KB (Combined) on chip
hw_tcache   =
hw_ocache   =
hw_memory   = 2048MB DDR266
hw_disk     = UltraATA/100
hw_disk1    =
hw_other1   =
hw_avail    =
sw_os       = Red Hat Linux 9.0 Professional
sw_compiler = GCC v3.3 and NAGware f95
sw_file     = ext3
sw_state    = Multi-user
sw_avail    =
sw_other    =
license_num =
tester_name =
test_date   =
company_name=
machine_name= spec

int=default=default=default:
notes00     =
notes01     = C   flags: -O3 -march=pentium4 -mfpmath=sse
notes02     = C++ flags: -O3 -march=pentium4 -mfpmath=sse
notes03     =
notes04     = PASS1 C flags: -fprofile-arcs
notes05     = PSSS1 C++ flags: -fprofile-arcs
notes06     = PASS2 C flags: -fbranch-probabilities
notes07     = PASS2 C++ flags: -fbranch-probabilities
notes08     =
notes185    = Portability flags:
notes186    =  186.crafty:  -DLINUX_i386
notes252    =  252.eon:     -DHAS_ERRLIST -DFMAX_IS_DOUBLE
notes253    =  253.perlbmk: -DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -
DSPEC_CPU2000_GLIBC22
```

```
notes254    =  254.gap:     -DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO
notes254_1  =               -DSYS_HAS_SIGNAL_PROTO -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO

fp=default=default=default:
notes00     =
notes01     = C flags: -O3 -march=pentium4 -mfpmath=sse
notes02     = Fortran flags: -O3 -Wc,-O3,-march=pentium4,-mfpmath=sse
notes03     =
notes04     = PASS1 C flags: -fprofile-arcs
notes05     = PASS1 FORTRAN flags: -fprofile-arcs
notes06     = PASS2 C flags: -fbranch-probabilities
notes07     = PASS2 FORTRAN flags: -fbranch-probabilities
notes08     =
notes167    = Portablility flags:
notes168    =  168.wupwise:  -dusty -dcfuns
notes178    =  178.galgel:   -fixed -kind=byte -dcfuns -dusty
notes197    =  187.facerec:  -kind=byte -dusty
notes191    =  191.fma3d:    -dusty -maxcontin=69
notes200    =  200.sixtrack: -dusty
notes301    =  301.apsi:     -dusty

# Enable 252.eon errno src.alt
252.eon=default=default=default:
srcalt=fmax_errno

##############  Do not touch anything below this line ##################################

###  Portability flags for the integer benchmarks

176.gcc=default=default=default:
EXTRA_CFLAGS=

186.crafty=default=default=default:
EXTRA_CFLAGS=-DLINUX_i386

197.parser=default=default=default:
EXTRA_CFLAGS=

252.eon=default=default=default:
EXTRA_CXXFLAGS=-DHAS_ERRLIST -DFMAX_IS_DOUBLE

253.perlbmk=default=default=default:
EXTRA_CFLAGS=-DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -
DSPEC_CPU2000_GLIBC22

254.gap=default=default=default:
EXTRA_CFLAGS=-DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -
DSYS_HAS_SIGNAL_PROTO -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO

### Portability flags for floating point benchmarks

# Fortran 77

168.wupwise=default=default=default:
EXTRA_FFLAGS = -dusty -dcfuns

171.swim=default=default=default:
```

172.mgrid=default=default=default:

173.applu=default=default=default:

200.sixtrack=default=default=default:
EXTRA_FFLAGS = -dusty

301.apsi=default=default=default:
EXTRA_FFLAGS = -dusty

Fortran 90

178.galgel=default=default=default:
EXTRA_FFLAGS = -fixed -kind=byte -dcfuns -dusty

187.facerec=default=default=default:
EXTRA_FFLAGS = -kind=byte -dusty

189.lucas=default=default=default:

191.fma3d=default=default=default:
#FOPTIMIZE = -O3
EXTRA_FFLAGS = -dusty -maxcontin=69

Appendix C. Apple Power Mac G5 SPEC CPU2000 Configuration File

```
#
# Apple gcc compiler with the NAG Fortran 95 compiler
#
action        = validate
tune          = base
ext           = gcc3
runlist       = all
output_format = all
reportable    = 1

teeout        = 1
teerunout     = 1

# Compilers
default=default=default=default:
CC=/usr/bin/gcc
CXX=/usr/bin/g++
FC=/usr/bin/f95imi

# Optimization Flags
default=default=default=default:
CXXOPTIMIZE = -fast
COPTIMIZE   = -fast
FOPTIMIZE   = -O3 -Wc,-fastf

# Flags for feedback optimization
default=default=default=default
fdo_pre0 = echo building in `pwd` ; rm -f *.da *.db
PASS1_CFLAGS = -fcreate-profile
```

```
PASS2_CFLAGS = -fuse-profile

PASS1_CXXFLAGS = -fprofile-arcs
PASS2_CXXFLAGS = -freorder-blocks-and-partition

PASS1_FFLAGS = -Wc,-fcreate-profile
PASS2_FFLAGS = -Wc,-fuse-profile

# Special libraries to link against.
LIBS= -lstmalloc

# Hardware description.
default=default=default=default:
hw_vendor   = Apple Computer, Inc.
hw_model    = Power Mac G5
hw_cpu      = PowerPC G5
hw_cpu_mhz  = 2000MHz
hw_fpu      = Yes
hw_ncpu     = 1
hw_ncpuorder= 1 to 2
hw_parallel = No
hw_pcache   = 64KBI+32KBD on chip
hw_scache   = 512KB (Combined) on chip
hw_tcache   = None
hw_ocache   = None
hw_memory   = 1.5GB DDR400
hw_disk     = ST3120026AS
hw_disk1    =
hw_other1   =
hw_avail    = August 2003
sw_os       = MacOS X 10.2.7 (6S43)
sw_compiler = Apple gcc 3.3 (1379) NAGWare Fortran 95 R4.2 (500)
sw_file     = HFS+
sw_state    = Multi-user
sw_avail    = August 2003
sw_other    =
license_num =
tester_name = Veritest
test_date   = 6/20/03
company_name= Apple Computer
machine_name=

int=default=default=default:
notes000=opt.C.flags:-fast -lstmalloc
notes000_1=opt.C.PASS1.flags=-fcreate-profile
notes000_2=opt.C.PASS2.flags=-fuse-profile
notes001=opt.CPP.flags:-fast -lstmalloc
notes001_1=opt.CPP.PASS1.flags=-fprofile-arcs
notes001_2=opt.CPP.PASS2.flags=-freorder-blocks-and-partition
notes002=port.176.gcc:-DHOST_WORDS_BIG_ENDIAN
notes003=port.186.crafty:-DLINUX_SPARC
notes004=port.197.parser:-D_POSIX_SOURCE
notes005=port.252.eon:-DHAS_ERRLIST -DFMAX_IS_DOUBLE
notes006=port.253.perlbmk:-DSPEC_CPU2000_LINUX_SPARC
notes007=port.254.gap:-DSYS_IS_BSD -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -
DSYS_HAS_SIGNAL_PROTO -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO -
DSYS_HAS_STDIO_PROTO
```

```
fp=default=default=default:
ONESTEP=yes
notes100=opt.C.flags:-fast -lstmalloc
notes101=opt.C.PASS1.flags=-fcreate-profile
notes102=opt.C.PASS2.flags=-fuse-profile
notes103=opt.FORTRAN.flags:-O3 -Wc,-fastf -lstmalloc
notes104=opt.FORTRAN.PASS1.flags=-Wc,-fcreate-profile
notes105=opt.FORTRAN.PASS2.flags=-Wc,-fuse-profile
notes106=port.168.wupwise:-dusty -dcfuns
notes107=port.178.galgel:-fixed -kind=byte -dcfuns -dusty
notes108=port.187.facerec:-kind=byte -dusty
notes109=port.189.lucas:
notes110=port.191.fma3d:-dusty -maxcontin=69
notes111=port.200.sixtrack:-dusty
notes112=port.301.apsi:-dusty

#############  Do not touch anything below this line
##############################

###  Portability flags for the integer benchmarks

164.gzip=default=default=default:
ONESTEP=yes

175.vpr=default=default=default:
ONESTEP=yes

176.gcc=default=default=default:
ONESTEP=yes
EXTRA_CFLAGS=-DHOST_WORDS_BIG_ENDIAN

181.mcf=default=default=default:
ONESTEP=yes

186.crafty=default=default=default:
ONESTEP=yes
EXTRA_CFLAGS=-DLINUX_SPARC

197.parser=default=default=default:
ONESTEP=yes
EXTRA_CFLAGS=-D_POSIX_SOURCE

252.eon=default=default=default:
# ONESTEP=yes # not yet supported for C++
EXTRA_CXXFLAGS=-DHAS_ERRLIST -DFMAX_IS_DOUBLE

253.perlbmk=default=default=default:
ONESTEP=yes
EXTRA_CFLAGS=-DSPEC_CPU2000_LINUX_SPARC

254.gap=default=default=default:
ONESTEP=yes
EXTRA_CFLAGS=-DSYS_IS_BSD -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -
DSYS_HAS_SIGNAL_PROTO -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO -
DSYS_HAS_STDIO_PROTO

255.vortex=default=default=default:
ONESTEP=yes
```

```
256.bzip2=default=default=default:
ONESTEP=yes

300.twolf=default=default=default:
ONESTEP=yes

### Portability flags for floating point benchmarks

# C

177.mesa=default=default=default:

# Fortran 77

168.wupwise=default=default=default:
EXTRA_FFLAGS = -dusty -dcfuns

171.swim=default=default=default:

172.mgrid=default=default=default:

173.applu=default=default=default:

200.sixtrack=default=default=default:
EXTRA_FFLAGS = -dusty

301.apsi=default=default=default:
EXTRA_FFLAGS = -dusty

# Fortran 90

178.galgel=default=default=default:
EXTRA_FFLAGS = -fixed -kind=byte -dcfuns -dusty

187.facerec=default=default=default:
EXTRA_FFLAGS = -kind=byte -dusty

189.lucas=default=default=default:
EXTRA_FFLAGS =

191.fma3d=default=default=default:
EXTRA_FFLAGS = -dusty -maxcontin=69
```

Appendix D. Dell Dimension 8300 SPEC CPU2000 Configuration File

```
action        = validate
tune          = base
ext           = FSF_f95
runlist       = all
output_format = all
feedback      = 1

teeout        = 1
teerunout     = 1
```

```
# Compilers
default=default=default=default:
CC=gcc
CXX=g++
FC=f95

# Optimization Flags
default=default=default=default:
CXXOPTIMIZE = -O3 -march=pentium4 -mfpmath=sse
COPTIMIZE = -O3 -march=pentium4 -mfpmath=sse
FOPTIMIZE = -O3 -Wc,-march=pentium4,-mfpmath=sse

# FDO Flags
default=default=default=default:
fdo_pre0 = rm -rf *.da
PASS1_CFLAGS = -fprofile-arcs
PASS1_CXXFLAGS = -fprofile-arcs
PASS1_FFLAGS = -Wc,-fprofile-arcs
PASS2_CFLAGS = -fbranch-probabilities
PASS2_CXXFLAGS = -fbranch-probabilities
PASS2_FFLAGS = -Wc,-fbranch-probabilities

default=default=default=default:
hw_vendor=Dell
hw_model=Dimension 8300
hw_cpu=Intel 875P chipset
hw_cpu1=Pentium 4 3.0 GHz Hyperthreading
hw_cpu2=800 MHz front-side bus
hw_cpu_mhz=3000
hw_fpu=Integrated
hw_ncpu=1
hw_ncpuorder=1
hw_parallel=No
hw_pcache=12k micro-ops I + 8KBD on chip
hw_scache=512KB(I+D) on chip
hw_tcache=N/A
hw_ocache=N/A
hw_memory=2048 MB
hw_disk=200 GB
hw_other=SuperDrive CD
hw_other1=ATI Radeon 9800 Pro (128MB DDR) Video
sw_os=RedHat 9 Linux
sw_compiler=GCC 3.3
sw_compiler1=NAGWare F95 Release 4.2(511)
sw_file=ext3
sw_state=Run-level 3
test_date=18 June 2003
tester_name=VeriTest

int=default=default=default:
notes00     =
notes01     = C   flags: -O3 -march=pentium4 -mfpmath=sse
notes02     = C++ flags: -O3 -march=pentium4 -mfpmath=sse
notes03     =
notes04     = PASS1 C flags: -fprofile-arcs
notes05     = PSSS1 C++ flags: -fprofile-arcs
notes06     = PASS2 C flags: -fbranch-probabilities
notes07     = PASS2 C++ flags: -fbranch-probabilities
```

```
notes08     =
notes185    = Portability flags:
notes186    =  186.crafty:  -DLINUX_i386
notes252    =  252.eon:     -DHAS_ERRLIST -DFMAX_IS_DOUBLE
notes253    =  253.perlbmk: -DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -
DSPEC_CPU2000_GLIBC22
notes254    =  254.gap:     -DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -
DSYS_HAS_TIME_PROTO
notes254_1  =               -DSYS_HAS_SIGNAL_PROTO -DSYS_HAS_ANSI -
DSYS_HAS_CALLOC_PROTO


fp=default=default=default:
notes00     =
notes01     = C flags: -O3 -march=pentium4 -mfpmath=sse
notes02     = Fortran flags: -O3 -Wc,-O3,-march=pentium4,-mfpmath=sse
notes03     =
notes04     = PASS1 C flags: -fprofile-arcs
notes05     = PASS1 FORTRAN flags: -fprofile-arcs
notes06     = PASS2 C flags: -fbranch-probabilities
notes07     = PASS2 FORTRAN flags: -fbranch-probabilities
notes08     =
notes167    = Portablility flags:
notes168    =  168.wupwise:  -dusty -dcfuns
notes178    =  178.galgel:   -fixed -kind=byte -dcfuns -dusty
notes197    =  187.facerec:  -kind=byte -dusty
notes191    =  191.fma3d:    -dusty -maxcontin=69
notes200    =  200.sixtrack: -dusty
notes301    =  301.apsi:     -dusty


# Enable 252.eon errno src.alt
252.eon=default=default=default:
srcalt=fmax_errno

#############  Do not touch anything below this line
################################

###  Portability flags for the integer benchmarks

176.gcc=default=default=default:
EXTRA_CFLAGS=

186.crafty=default=default=default:
EXTRA_CFLAGS=-DLINUX_i386

197.parser=default=default=default:
EXTRA_CFLAGS=

252.eon=default=default=default:
EXTRA_CXXFLAGS=-DHAS_ERRLIST -DFMAX_IS_DOUBLE

253.perlbmk=default=default=default:
EXTRA_CFLAGS=-DSPEC_CPU2000_LINUX_I386 -DSPEC_CPU2000_NEED_BOOL -
DSPEC_CPU2000_GLIBC22

254.gap=default=default=default:
```

```
EXTRA_CFLAGS=-DSYS_IS_USG -DSYS_HAS_IOCTL_PROTO -DSYS_HAS_TIME_PROTO -
DSYS_HAS_SIGNAL_PROTO -DSYS_HAS_ANSI -DSYS_HAS_CALLOC_PROTO

### Portability flags for floating point benchmarks

# Fortran 77

168.wupwise=default=default=default:
EXTRA_FFLAGS = -dusty -dcfuns

171.swim=default=default=default:

172.mgrid=default=default=default:

173.applu=default=default=default:

200.sixtrack=default=default=default:
EXTRA_FFLAGS = -dusty

301.apsi=default=default=default:
EXTRA_FFLAGS = -dusty

# Fortran 90

178.galgel=default=default=default:
EXTRA_FFLAGS = -fixed -kind=byte -dcfuns -dusty

187.facerec=default=default=default:
EXTRA_FFLAGS = -kind=byte -dusty

189.lucas=default=default=default:

191.fma3d=default=default=default:
#FOPTIMIZE = -O3
EXTRA_FFLAGS = -dusty -maxcontin=69
```

Appendix E. Apple Power Mac G5 GCC 3.3 Compiler and Linking Option Descriptions

-fast

This flag is used with C and C++ and specifically targeted to the G5 and enables G5 specific instruction usage, tuning and 64 bit arithmetic. In addition to enabling the -O3 optimization level, it also enables the use of C99 aliasing rules and relaxed IEEE math operations.

-fastf

This flag is used with FORTRAN and specifically targeted to the G5 and enables G5 specific instruction usage, tuning and 64 bit arithmetic. In addition to enabling the -O3 optimization level, it also enables the use of C99 aliasing rules and relaxed IEEE math operations.

-fprofile-arcs

This flag is used with C++ during PASS1 of the runs for profile feedback generation. This flag enables profile feedback information collection during a training run that is used in building an optimized version of the application.

-freorder-blocks-and-partition

This flag is used with C++ during PASS2 to build the final SPEC binary files when using feedback directed optimization. This flag enables the use of the profile information collected in the training run for application optimization.

-fcreate-profile

This flag is used with both C and FORTRAN during PASS1 of the runs for profile feedback generation. This flag enables profile feedback information collection during a training run that is used in building an optimized version of the application.

-fuse-profile

This flag is used with both C and FORTRAN during PASS2 to build the final SPEC binary files when using feedback directed optimization. This flag enables the use of the profile information collected in the training run for application optimization.

-lstmalloc

Link fast malloc libraries. The implementation is geared for speed rather than memory efficiency and is single-threaded which makes it unsuitable for many uses. Special provisions are made for very small allocations (less than 4 bytes).

Appendix F. Dell Dimension 8300 and Dell Precision 650 GCC 3.3 Compiler Option Descriptions

-O3

Desired level of optimization.

-march=pentium4

Generate instructions for the Pentium4 architecture.

-mfpmath=sse

Generate floating point arithmetics for sse. Use scalar floating point instructions present in the SSE instruction set. This instruction set is supported by Pentium3 and newer chips, in the AMD line by Athlon-4, Athlon-xp and Athlon-mp chips. The earlier version of SSE instruction set supports only single precision arithmetics, thus the double and extended precision arithmetics is still done using 387. Later version, present only in Pentium4 and the future AMD x86-64 chips supports double precision arithmetics too.

`-Wc, option`

Pass *option* directly to the host C compiler when compiling (producing the .o file). Multiple options may be specified in a single *-Wc,* option by separating them with commas.

`-fprofile-arcs`

Instrument *arcs* during compilation to generate coverage data or for profile-directed block ordering. During execution the program records how many times each branch is executed and how many times it is taken.

`-fbranch-probabilities`

After running a program compiled with –fprofile-arcs you can compile it a second time using -fbranch-probabilities, to improve optimizations based on the number of times each branch was taken. When the program compiled with -fprofile-arcs exits it saves arc execution counts to a file called *sourcename*.da for each source file The information in this data file is very dependent on the structure of the generated code, so you must use the same source code and the same optimization options for both compilations.

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