Benchmarking MCFOCUS on various platforms

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1 System setup

The systems tested were:

- Single processor 133 MHz Pentium
- Dual processor 300 MHz Pentium II (Klamath) – 440BX motherboard
- Dual processor 400 MHz Pentium II (Deschutes) – 440BX motherboard
- Dual processor 450 MHz Pentium II (Deschutes) – 440BX motherboard
- Dual processor 550 MHz Pentium III (Katami – 0.25 μm) – 440BX motherboard
- Dual processor 600 MHz Pentium III (Coppermine – 0.18 μm) – 440BX motherboard
- Dual processor 600 MHz Pentium III (Coppermine – 0.18 μm) – 820 motherboard
- Dual processor 800 MHz Pentium III (Coppermine – 0.18 μm) – 440BX motherboard
- Dual processor 800 MHz Pentium III (Coppermine – 0.18 μm) – 820 motherboard
- Dual processor 850 MHz Pentium III (Coppermine – 0.18 μm) – 440BX motherboard
- Dual processor 1000 MHz Pentium III (Coppermine – 0.18 μm) – VIA 694XDP motherboard
- Single processor 1000 MHz Athlon (Thunderbird – 0.18 μm) – VIA KT133 motherboard
- Dual processor 1200 MHz Athlon MP (Palomino – 0.18 μm) – Tyan S2462 motherboard
- Single processor 1500 MHz Pentium IV
- Single processor Alpha 21064 233 MHz – AlphaStation 200/233
- Single processor Alpha 21164LX 533 MHz – PC
- Single processor Alpha 21164SX 533 MHz – PC
- Single processor Alpha 21264 466 MHz – XP900
- Single processor Alpha 21264 600 MHz – XP1000
- Multi processor Sun E4500 400 MHz
- Multi processor SGI IP27 196 MHz – Origin 200
- Multi processor SGI IP27 300 MHz – Origin 2000

The code run was MCFOCUS, the FOCUS Monte Carlo and reconstruction program. Each test was run with 10,000 generic (ccbar) events with no trigger applied. The time reported by the program (CPU time) was used to determine the performance.

For the 1 GHz x86 machines, tests with different compiler options were also performed in an attempt to improve performance. First, the libraries were compiled with a new version of g77 (0.5.25 instead of 0.5.24) using the same options. This is referred to as "g77n" and gave a 4–7% improvement. For the Pentium III family, including the 686 machine architecture flag (`-march=pentiumpro`) gave significant improvement. For the Athlon chip, unrolling loops (`-funroll-loops`) gave significant improvement. Each of these did not improve performance on the other chip. The other options tried, `-O2` versus `-O3` and `-malign-double` also had no effect. The end result of optimizing the optimization flags gave a 7–9% performance increase.

Also for the 1 GHz x86 machines I tried using other compilers. The Absoft compiler had serious problems with the E831 code and it seemed to run incorrectly and no faster. Some of the problems include dealing with `BLOCK DATA` files and interpreting `TAB`'s. The Portland Group compiler was much better. It caught a problem in a couple of routines which had never been spotted before (not serious). The only other code requiring a change was the way octal constants are written. In our code we use `O"1000"` to represent 512 in a few places. All of our platforms also recognize `'1000'O` as well but the Portland Group only accepts this second method. I compiled our libraries with various optimizations and found that `-O2` (highest) and `-Munroll` gave nearly optimal code. The optimizations which are specific to Pentium III and/or Athlons did not improve the speed. I have also tested the Intel Beta-release of its Fortran compiler. This compiler chokes on a generic `SAVE` and specific `SAVE` statement in the same routine. After eliminating these, all the routines compile. Linking proved to be a problem for which the solution was to link with gcc (not g77). This has something to do with shared versus static libraries and with the FTT libraries. The fastest code was obtained using `-O2` and `-unroll`. The Intel and Portland Group generated much faster code than g77.

The MCFOCUS Solaris libraries are currently built with no optimization. I ran the code as is and with standard optimization ("O") which increases performance by a factor of two.

2 Performance

Processor	Clock (MHz)	FSB (MHz)	MCFOCUS Time (s)	MCFOCUS Evt/s	MCFOCUS Evt/s/GHz	SPEC95 INT	SPEC95 FP
Pentium	133	66	9237	1.08	8.14	2.39	1.51
P-II Kl	300 (300.69)	66	2497	4.00	13.30	11.9	8.2
P-II De	400 (397.34)	100	1848	5.41	13.62	15.8	11.4
P-II De	450 (451.03)	100	1673	5.98	13.25	17.3	11.9
P-III Ka	550 (551.26)	100	1346	7.43	13.48	22.3	13.8
Celeron Cu	600 (598.61)	66	1262	7.92	13.24		
P-III Cu	600 (601.38)	100	1124	8.90	14.79	24.6	14.9
P-III Cu	600R (598.14)	100	1133	8.83	14.76	24.6	14.9
P-III Cu	800 (801.84)	100	856	11.68	14.57	37.6	24.4
P-III Cu	800R (794.67)	133	864	11.57	14.56	38.2	28.6
Duron	800 (801.43)	200	874	11.44	14.28		
P-III Cu	850 (851.95)	100	816	12.25	14.38		
P-III Cu	1000 (998.37)	133	716	13.97	13.99	46.1	31.7
P-III g77n	1000 (998.37)	133	686	14.58	14.60	46.1	31.7
P-III g77nf	1000 (998.37)	133	623	16.05	16.08	46.1	31.7
P-III pgf	1000 (998.37)	133	517	19.34	19.37	46.1	31.7
P-III Intel	1000 (998.37)	133	490	20.41	20.44	46.1	31.7
Athlon	1000 (1002.31)	200	648	15.43	15.39	42.9	29.4
Athlon g77n	1000 (1002.31)	200	600	16.67	16.63	42.9	29.4
Athlon g77nf	1000 (1002.31)	200	558	17.92	17.88	42.9	29.4
Athlon pgf	1000 (1002.31)	200	432	23.15	23.09	42.9	29.4
Athlon Intel	1000 (1002.31)	200	431	23.20	23.15	42.9	29.4
AthlonMP pgf	1200 (1194.68)	200	348	28.74	24.05	52	48
P4	1500	400	720	13.89	9.26	57.1	57.2
A21064	233		4784	2.09	8.97	3.45	3.95
APC164LX	533		1583	6.32	11.85		
APC164SX	533		1174	8.52	15.98	12.4	14.1
A21264A	466		726	13.77	29.55	21.5	39.7
A21264A	667		490	20.41	30.60	33.2	53.9
Sun E4500	400		6166	1.62	4.05	14.9	26.5
Sun E4500 O	400		3104	3.22	8.05	14.9	26.5
SGI IP27	196		2630	3.80	19.40	10.9	17.7
SGI IP27	300		1737	5.76	19.19	18.1	30.1

Table 1: Results of running 10,000 ccbar MCFOCUS events on various machines and with various compiler options. SPEC CPU95 base results are presented for comparison.

3 Analysis

As we have known for a while, the x86 style computers are very close to the performance achieved by the Alpha processor while the Sun and SGI machines are clearly not competitive. The Pentium 4 chip is not impressive in running MCFOCUS even though the SPEC benchmarks indicate a high performance. This is probably due to two things. First, the SPEC benchmarks were compiled using a new Intel compiler which takes advantage of the Pentium 4 strengths and minimizes its weaknesses. Unfortunately, g77 knows of nothing after the Pentium Pro so it has no MMX, SSE or SSE2 instructions to work with. Second, the Pentium 4 architecture has excellent bandwidth between all parts of the machine which is not very useful for the MCFOCUS code which is very CPU intensive. The AMD Athlon is 10–20% faster per clock than the Pentium III depending on the compiler. With a summer release of dual-processor motherboards this will become a very attractive solution.