# Computer Architecture (CMPEN 431)

## Report

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There are two files in reference:

a) p1.c
b) p1_mine.c

**p1.c** was given to us, which has a long division function and **p1_mine.c** has division by shift and subtract. Running gcc compiler with -O0 and -O3 optimizations, we get four files:

a) p1_unoptimized
b) p1_optimized
c) p1_mine_unoptimized
d) p1_mine_optimized

Perf command was run on these files 4 times

Three commands were used per file:

**a) perf stat ./program**
**b) perf stat -e L1-cache-misses ./program**
**c) perf stat -e L1-dcache-misses ./program**

**1. Performance counter stats for 'p1_unoptimized':**

536.60 msec task-clock:u # 0.991 CPUs utilized

0 context-switches:u # 0.000 K/sec

0 cpu-migrations:u # 0.000 K/sec

128 page-faults:u # 0.239 K/sec

1,579,683,449 cycles:u # 2.944 GHz

2,086,625,805 instructions:u # 1.32 insn per cycle

427,801,664 branches:u # 797.249 M/sec

15,756,547 branch-misses:u # 3.68% of all branches

9,584 L1-icache-misses:u

5,797 L1-dcache-misses:u

0.541646783 seconds time elapsed

0.534311000 seconds user

0.004002000 seconds sys

2. **Performance counter stats for './p1_optimized':**

348.19 msec task-clock:u # 0.985 CPUs utilized

0 context-switches:u # 0.000 K/sec

0 cpu-migrations:u # 0.000 K/sec

129 page-faults:u # 0.370 K/sec

926,339,430 cycles:u # 2.660 GHz

1,640,627,042 instructions:u # 1.77 insn per cycle

372,825,328 branches:u # 1070.739 M/sec

10,924,011 branch-misses:u # 2.93% of all branches

8,336 L1-icache-misses:u

5,684 L1-dcache-misses:u

0.353389582 seconds time elapsed

0.346921000 seconds user

0.003025000 seconds sys

3. **Performance counter stats for './p1_mine_unoptimized':**

1,728.11 msec task-clock:u # 0.997 CPUs utilized

0 context-switches:u # 0.000 K/sec

0 cpu-migrations:u # 0.000 K/sec

128 page-faults:u # 0.074 K/sec

5,812,477,472 cycles:u # 3.363 GHz

8,950,068,313 instructions:u # 1.54 insn per cycle

1,034,719,349 branches:u # 598.757 M/sec

23,182,414 branch-misses:u # 2.24% of all branches

11,702 L1-icache-misses:u

7,263 L1-dcache-misses:u

1.732749171 seconds time elapsed

1.723705000 seconds user

0.005998000 seconds sys

4. **Performance counter stats for './p1_mine_optimized':**

Performance counter stats for './p1_optimized':

347.29 msec task-clock:u # 0.987 CPUs utilized

0 context-switches:u # 0.000 K/sec

0 cpu-migrations:u # 0.000 K/sec

129 page-faults:u # 0.371 K/sec

924,204,907 cycles:u # 2.661 GHz

1,640,627,046 instructions:u # 1.78 insn per cycle

372,825,332 branches:u # 1073.534 M/sec

10,885,113 branch-misses:u # 2.92% of all branches

0.351764344 seconds time elapsed

0.345982000 seconds user

0.002991000 seconds sys655,905 branch-misses:u # 0.10% of all branches

8,518 L1-icache-misses:u

5,203 L1-dcache-misses:u

0.903229647 seconds time elapsed

0.897057000 seconds user

0.002996000 seconds sys

**Conclusion:**

It is seen that the performance of using optimized compilation (-O3) gives a better performance in terms of CPU utilization, Number of cycles used, Number of instructions per cycle, number of branches, number of branch misses, L1-dcache and L1-icache misses.

The number of L1-dcache and L1-icache misses, number of instructions per cycle and number of cycles, number of branches and branch misses significantly reduce with the optimized compilation.

The performance of division by shift and subtract algorithm is better in terms of the six parameters that we have used from perf statistics. It can be seen that both p1_mine_optimized and p1_mine_unoptimized have better performances than their counterparts – p1_optimized and p1_unoptimized according to the perf statistics provided above.