ELC 463 - LABORATORY #1

CACHE SIMULATOR

The purpose of this laboratory is to study, via simulation, the performance of memory management policies and memory configurations for cache memory systems. For the simulations, the trace files described below will be used.

The trace files are available on the class web site at http://www.tcnj.edu/~hernande/padir/teaching.html, under **RESOURCES** and **Trace Files**. Download the two trace files to your personal directory.

The trace files have been generated on a PC. The two programs traced have been stripped by removing cache hits observed by a cache with 32 sets, 1-way associative, with 8 contiguous addresses per line.

Format:

Each memory reference is recorded as a three-byte word. All references are stored successively without any delimiters. Both trace files are 180,000-bytes long, and contain 60,000 3-byte memory references. The stripping algorithm eliminated 90% of the original references from original traces approximately 600,000 references long.

The first byte of a three-byte word is the least-significant byte, the third one is the most-significant byte. The lower three-bits of the least-significant byte are always cleared, since only the base address of the line containing the memory word referenced is recorded.

The first three references of `trace1.dat` are `038FE8`, `038FF8`, and `039000`, in hexadecimal form. DEBUG prints this information as follows:

```
debug trace1.dat
-d
5651:0100 E8 8F 03 F8 8F 03 00 90-03 80 75 0C 08 90 03 E8  ..........u.....
5651:0110 FF 07 F0 FF 07 78 96 03-E8 8D 03 F0 8D 03 F0 FF  .....x..........
```

Prepare a program (use the programming language of your choice) to simulate a cache memory system. The cache memory system will be evaluated under two replacement policies:

1. Least Recently Used (LRU);

2. FIFO.

For each of these policies, performance as a function of specific cache parameters will be compared. The parameters are:

1. L - number of bytes per line of cache memory;

2. K - number of lines per set;

3. N - number of sets.

The total number of bytes of cache memory is given by the product LKN and L=8 will be used throughout the simulations. Use the two trace files to run simulations with cache configured as given below:

Sim 1: Replacement Policy = FIFO; KN=64; K=2.

Sim 2: Replacement Policy = FIFO; KN=64; K=4.

Sim 3: Replacement Policy = FIFO; KN=64; K=8.

Sim 4: Replacement Policy = FIFO; KN=64; K=16.

Sim 5: Replacement Policy = FIFO; KN=256; K=2.

Sim 6: Replacement Policy = FIFO; KN=256; K=4.

Sim 7: Replacement Policy = FIFO; KN=256; K=8.

Sim 8: Replacement Policy = FIFO; KN=256; K=16.

Sim 9: Replacement Policy = LRU; KN=64; K=2.

Sim 10: Replacement Policy = LRU; KN=64; K=4.

Sim 11: Replacement Policy = LRU; KN=64; K=8.

Sim 12: Replacement Policy = LRU; KN=64; K=16.

Sim 13: Replacement Policy = LRU; KN=256; K=2.

Sim 14: Replacement Policy = LRU; KN=256; K=4.

Sim 15: Replacement Policy = LRU; KN=256; K=8.

Sim 16: Replacement Policy = LRU; KN=256; K=16.

The $\text{MISS RATE} = \dfrac{\text{TOTAL \# OF MISSES}}{\text{TOTAL \# OF REFERENCES}}$ should be recorded for each simulation. Sim i, i= 1 to 16, should be run for each of the two trace files and the miss rate recorded for each.

The minimum deliverables for this laboratory are the following:

1. A flow diagram of your simulator program;

2. A copy of your simulator source code;

3. The computer outputs listing your results;

4. Appropriate graphs describing your results;

5. Discussion and conclusions concerning your findings.

A report with, at a minimum, all the items requested to be turned in is to be submitted by each team by the due date discussed in class. All reports should be written in a word processor and similar productivity computer tools; no hand written reports will be accepted.

GRADING RUBRIC: The total grade for this assignment will be 29 points normalized to 100% for your report. Parts (1) and (2) above will be worth 1 point each, part (3) will be worth 16 points, part (4) will be worth 4 points, and (5) will be worth 1 point. The rest of your report will be worth 6 points, for a total of 29 points.

REPORT FORMAT: Free form, but it must be:

a. One report per team.

b. Have a cover sheet with identification: Title, Class, Your Name, etc.

c. COMPLETELY word-processed

d. Double spaced

e. 12 pt Times New Roman font

f. Fully justified (optional)

g. Outline of the body of the report: Introduction, Problem Description, Results, Discussion, and Conclusions.