

ENCM 369
Lab 10
B03

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byte offset width = \log_2 (number of bytes per word)

block offset width = \log_2 (number of words per block)

number of set bits = $\log_2 (S)$ where S is # of sets in cache.

tag width = address width - # set bits - block offset width - byte offset width.

C = capacity = $S \times B \times B_{pl}$ = # sets \times bytes per line

C = S \times words per block \times bytes per word

Exercise A :

Question 3)

block size = 8 words , capacity = 16KB

a) $C = S(\text{words per block})(\text{bytes per word})$

$$S = C / (\text{words per block})(\text{bytes per word})$$

$$S = (16 \times 2^{10} \text{ bytes}) / (8 \text{ words/block} \times 4 \text{ bytes/word})$$

S = 512 sets

b) byte offset = $\log_2 (4 \text{ bytes/word}) = 2$

$$\text{block offset} = \log_2 (8 \text{ words/block}) = 3$$

$$\text{set bits} = \log_2 (512 \text{ sets}) = 9$$

$$\text{tag} = 32 - 9 - 3 - 2 = 18$$



c) # cells = $S(\text{v-bit} + \text{tag width} + (\frac{\text{words}}{\text{block}} \times \frac{\text{bytes}}{\text{word}} \times \frac{\text{bits}}{\text{byte}}))$

$$= (512 \text{ sets})(1 \text{ bit} + 18 \text{ bits tag} + (\frac{8 \text{ words}}{\text{block}} \times \frac{4 \text{ bytes}}{\text{word}} \times \frac{8 \text{ bits}}{\text{byte}})))$$

= 140 800 SRAM cells

Question 4

a) $\frac{64 \text{ bits}}{\text{word}} = \frac{8 \text{ bytes}}{\text{word}}, C_L = 32 \text{ KB}, \frac{64 \text{ bytes}}{\text{block}} = \frac{64 \text{ bytes}}{\text{block}} \times \frac{\text{word}}{8 \text{ bytes}} = \frac{8 \text{ words}}{\text{block}}$

$$\text{byte offset} = \log_2 (8 \text{ bytes/word}) = 3 \text{ bits}$$

$$\text{block offset} = \log_2 (8 \text{ words/block}) = 3 \text{ bits}$$

$$C = S(8 \text{ words/block})(8 \text{ bytes/word})$$

$$S = 32 \times 2^{10} \text{ bytes}/(8 \text{ words/block})(8 \text{ bytes/word})$$

$$S = 512 \text{ sets}$$

$$\text{set bits} = \log_2 (512 \text{ sets}) = 9 \text{ set bits}$$

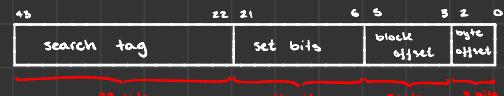


b) $C = S(8 \text{ words/block})(8 \text{ bytes/word})$

$$S = 4 \times 2^{20} \text{ bytes}/(8 \text{ words/block})(8 \text{ bytes/word})$$

$$S = 65536 \text{ sets}$$

$$\text{set bits} = \log_2 (65536 \text{ sets}) = 16 \text{ set bits}$$



c) # cells = $S(\text{v-bit} + \text{tag width} + (\frac{\text{words}}{\text{block}} \times \frac{\text{bytes}}{\text{word}} \times \frac{\text{bits}}{\text{byte}}))$

$$= (65536 \text{ sets})(1 \text{ bit} + 22 \text{ bits tag} + (8 \text{ words} \times 8 \text{ bytes} \times 8 \text{ bits}))$$

$$= \boxed{35061760 \text{ SRAM cells}}$$

Exercise B:

Part I :

```
Youssefs-MacBook-Pro:exB youssef$ gcc -Wall sim1.c
Youssefs-MacBook-Pro:exB youssef$ ./a.out < mergesort_trace.txt
104298 reads
88429 read hits
73410 writes
64076 write hits
overall miss rate: 14.18%
Youssefs-MacBook-Pro:exB youssef$ ./a.out < heapsort_trace.txt
64705 reads
49791 read hits
68419 writes
68401 write hits
overall miss rate: 11.93%
```

Part II :

```
Youssefs-MacBook-Pro:exB youssef$ gcc -Wall sim2.c
Youssefs-MacBook-Pro:exB youssef$ ./a.out < mergesort_trace.txt
104298 reads
71676 read hits
73410 writes
44962 write hits
overall miss rate: 34.37%
Youssefs-MacBook-Pro:exB youssef$ ./a.out < heapsort_trace.txt
64705 reads
26363 read hits
60419 writes
60034 write hits
overall miss rate: 30.95%
```

The results of part 2 suggest that there is a lower spatial locality of reference. This is expected since we are replacing more data on cache misses since there are 8 word blocks per set

Part III

```
Youssefs-MacBook-Pro:exB youssef$ gcc -Wall sim3.c
Youssefs-MacBook-Pro:exB youssef$ ./a.out < mergesort_trace.txt
104298 reads
77494 read hits
73410 writes
64799 write hits
overall miss rate: 25.56%
Youssefs-MacBook-Pro:exB youssef$ ./a.out < heapsort_trace.txt
64705 reads
32278 read hits
60419 writes
60114 write hits
overall miss rate: 26.16%
Youssefs-MacBook-Pro:exB youssef$ █
```