

CS147, Sec 01
Homework III
Craig Huff

1. Assume an word addressable memory and a register file on a computing system contains the following data at an instance of time during running of a program. What is the operand value retrieved

- (a) Direct Addressing: [Memory Content] 0x10003014
(b) Indirect Addressing: [Memory Addr] 0x10003014 \longrightarrow
[Content New Addr] 0x00000012
(c) Register Addressing: [Reg 7 Content] 0x10003013
(d) Register Indirect Addressing: [Reg 7 Content] 0x10003013 \longrightarrow [Memory Content] 0x00000010
(e) Displacement Addressing:
[Reg 20 Content] 0x10003018 + [Offset Addr] $\sim(0xF6) + 1 =$
[Memory] 0x1000300E \longrightarrow Content: 0x00000001

2. **1 million total memory access calls. 25% will be remote**

Local Calls: $(1,000,000 \times .75) \times 50\text{ns} = 37,500,000\text{ns}$

Remote Calls: $(1,000,000 \times .25) \times 150\text{ns} = 45,000,000\text{ns}$

Total Nanoseconds: $37,500,000 + 45,000,000 = 82,500,000$

Total Time: 82.5 ms

3. **HHD - Computer 1**

$2\text{Mb} / 2\text{Kb} \times 1\text{ms} = 1024 \text{ ms}$

$2\text{Mb} / 100\text{Mbps} = .16\text{s}$

$1.024\text{s} + .16\text{s} = 1.184\text{s}$

SSD - Computer 2

$2\text{Mb} / 1\text{Kb} \times 300\mu\text{s} = .6144$

Machine 2 is faster by 1.927x

4. **Total Number of Instructions** = $(10,000 \times 6) + 3 = 60,0003$

Ideal Run Time = $60,003 \times 5 / 1 \times 10^9 = 300.15\mu\text{s}$

Stall Time of Data Cache + Stall Time of Instruction Cache: $(10,001 \times .1) \times 150\text{ns}$
 $+ (60,003 \times .05) \times 150\text{ns} = 600,037.5\text{ns} = 600.037\mu\text{s}$

Total Execution Time = $300.15 + 600.37 = 900.52\mu\text{s}$

5. Cache Memory Problem

(a) **Data in the cache:** $2^{14} + 2^{10} = 2^{24} = 16\text{MB}$

(b) **Size of the cache:** $(1024 + 2) \times 2^{14} = 16,809,984 \times 16\text{KB} / 1024 = 16,416$

(c) **Blocks in the memory:** $4\text{GB} / 1\text{KB} = 2^{32} / 2^{10} = 2^{22}$ or 4,194,304 blocks

6. 8 Way Associative Cache Memory Problem for address 0x30AB23F2

- (a) 11 bit tag
11 bit cache line index
 $32 - 11 - 11 = 10\text{-bit block index}$

0x30AB23F2 = 0011 0000 1010 1011 0010 0011 1111 0010

Tag: 00110000101

Cache Line Index: 01011001000

Block Index: 1111110010

- (b) **Size of cache:** $(12 + 8 * 1024) * 2^{11} = 16,801,792 / 1024\text{KB} = 16,408\text{KB}$

7. Virtual Memory Problem

- (a) Total Number of Instructions = $(10,000 * 6) + 3 = 60,003$
Ideal Run Time = $1,000,000 * (2 * 1\text{ns}) = 2,000,000\text{ns} = .002\text{sec}$
TLB Miss = $1,000,000 * .25 * 20\mu\text{s} = 5,000,000\mu\text{s} = 5\text{ sec}$
Cache Miss = $1,000,000 * .1 * 150 = 15,000,000 = 15\text{ sec}$
Page Fault = $1,000,000 * .0001 = 100\text{ sec}$
Total Execution Time = $.002\text{s} + 5\text{s} + 15\text{s} + 100\text{s} = 120.002\text{ seconds}$

- (b) Virtual Address 0x4CD67821: 0100 1100 1101 0110 0111 **1000 0010 0001**

————→ **Block Offset**

TLB Entry 0x4CD67: 0010 1000 0111 0000 0001

0010 1000 0111 0000 0001 1100 0010 0001

Tag: 00101000011

Cache Line Index: 10000000110

Block Index: 0000100001