

George Kern - Scheller 480 686762

$$L \frac{1}{T} = 7CPI$$

2.4 GHz

miss time = 40 ns

data miss rate = 5% instruction mis = 2%

$$I_s = \frac{I}{P} \cdot (CPI + MSIPI) \cdot \frac{S}{C}$$

$$7 + (0.3 \cdot 0.7) \cdot 7 = 7.3$$

$$\cdot \frac{7.3 C}{1 I} \cdot 2.4 \times 10^9 \frac{s}{C}$$

$$CPI = 7.07 \quad 0.30\%$$

$$\frac{I_s}{2.4 \times 10^9 C} \left[ \left( \frac{7C \cdot 0.7}{PI} + 0.3(0.75 \cdot 960) \right) \right] = K$$

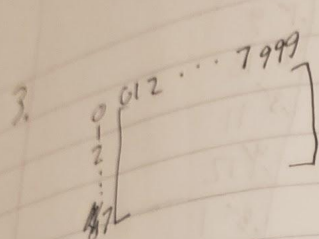
$$4.9 \cdot 14.4$$

$$40 \text{ ns} = 40 \times 10^{-9} s \quad \frac{40 \cdot 24}{2.4 \times 10^9}$$

$$\frac{960 \cancel{C}}{C} \text{ per fault}$$

$$a.) \frac{1s}{2.4 \times 10^9 C} \cdot (0.98 \cdot K + (0.02 \cdot 960)) = 19.2$$

	16x1	4x4	DM 16x1	4x4
2.	1 M	M	1	1-9
	4 M	H	2	2-10
	8 M	M	3	3-11
	5 M	H	4	4-12
	20 M	M	5	5-1
	17 M	H	6	6-2
	19 M	H	7	7-3
	56 M	M	8	8-4
	9 M	M	9	9-5
	11 M	H	10	10-6
	4 H	M	11	11-7
	5 H	M	12	12-8
	6 M	H	13	13-17
	9 H	H	14	14-18
	17 H	M	15	15-19
			16	16-20



1.  $32/8 = 4$      $16/4 = 4$  ints

2.  $I, J$  and  $B[0][0] \rightarrow B[7][0]$  Show temporal locality but only if  $B$  is a char array. otherwise just  $I, J$  because only they fit in cache long/short enough to not be kicked
3.  $B$  and  $A[\overset{I}{I}][\overset{J}{J}]$  exhibit a spacial locality because they go row wise

5. here it is still just  $I, J$  because of the size of the cache
6. only  $A[I][J]$  benefits from spacial locality



4.)

3 180 43 2 191 88 190 14 181 44  
inHex 3 3 B4 , 2B , 2 , BF , 58 , BE , E , B5 , 2C  
T: 0I: 0 off: 3 | T: I: 0: 40 |

166 253  
in Hex, BA FD

$$B = 10 \text{ dB}$$

Offset  $L = \frac{1}{f_a}$  bei  $B_1 = 2$

index = 4

$$\tau_{a\gamma} =$$

index = 4  
Tag =

16 1w block

	Tag	ind	off
3	0	0	3
B4	2	13	0
2B	0	10	3
2	0	0	2
BP	2	15	3
58	2	12	0
BE	3	7	2
E	0	3	2
B5	2	13	1
2C	0	15	2
BA	2	14	2
F0	3	15	1

101  
01010101  
101111  
0101100  
110111  
110111  
010101  
0101110  
10111010  
11111101

4.2

offset = 3

index = 3

tag = 26

	b	tag	ind	off	H/M
3	0000, 0011	0	0	3	M
B4	10, 11 0100	2	6	4	M
2B	00, 0 1011	0	5	3	M
2	0000 0010	0	0	2	H
BF	10, 11 1111	2	7	7	M
58	01, 01 1000	1	3	0	M
BE	10, 11 1110	2	7	6	<del>M</del>
E	0000 1110	0	1	6	M
B5	10, 11 0101	2	6	5	M
2C	00, 10 1100	0	5	4	H
BA	10, 11 1010	2	7	2	H
FD	11, 11 1101	3	7	5	M

Cach 2x8

	Tag
0	0
1	0
2	2
3	1
4	
5	0
6	2

→ 23

tag=26 ind=2 off=4

4.3

	b	Tag	Ind	off	H/m
3	0000 0011	0	0	3	H/m
B4	1011, 0100	2	3	4	M
2B	0010, 1011	0	2	B	M
2	0000 0010	0	0	2	M
BF	1011 1111	2	3	F	H
58	0101 1000	1	1	8	H
BE	1011 1110	2	3	E	M
F	0000 1110	0	0	E	H
B5	1011 0101	2	3	5	H
2C	0010 1100	0	2	C	H
BA	1011 1010	2	3	A	H
F0	1111 1101	3	3	D	M

Cycles

$C1_T = 10 \cdot 25 + 2 \cdot 12 = 274$  4x4 Cache

$C2_T = 8 \cdot 25 + 3 \cdot 12 = 236$

$C3_T = 5 \cdot 25 + 5 \cdot 12 = 185$

0	0
1	1
2	0
3	2, 3

$4 \times 4 \cdot \frac{5}{12}$

$16 \times 1 \cdot \frac{10}{12}$

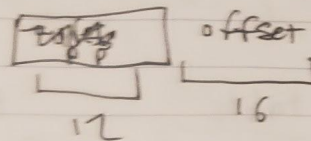
$8 \times 2 \cdot \frac{8}{12}$

a.) C3 has the lowest miss rate.

b.) C3 is the best Design

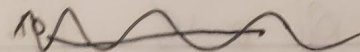


6.  $PS = 64KB = 2^0 \cdot 2^6 \rightarrow 16 \text{ bit}$   
 286 address space



- a.) 0X FF FFFF
- b.) 0X 01 2345
- c.) 0X 05 4321
- d.) 0X 90 0000

0	0X05
1	0X07
2	0X30
3	0X01
4	0X11
5	0XFF
6	0X07
7	0X00
8	0XAA
9	0X70



a = outside given pages  
 b = 0X99 2345  
 c = 0XFF 4321  
 d = outside given pages

7.) 4 Kb Pages  $\rightarrow 2^2 \cdot 2^{10} \rightarrow 12 \text{ bits offset}$   
 - 4 669  $\rightarrow 49669$

a.)

Page table			H/M	Page table	TLB	fault
0	1	5	4669	H	H	0
1	0	7	2227	M	M	1
2	0	13	916	M	M	1
3	1	14	587	H	H	0
4	1	15	876	M	M	1
5	1	11	608	H	M	0
6	0	Disk	225	M	M	1
7	1	4				
8	0	16				
9	0	18				
10	1	3				
11		12				

Tag of TLB

4	2	3	4	6	2	4	
11	4	13	4	6	2	9	
7	11	4	13	3	4	2	
3	3	11	4	13	3	4	8
4	7	3	4	11	13	13	4

TLB

1	9	18
1	2	17
1	8	16
1	4	15



b.

$$16 \text{ Kb} = 16 \times 1024$$

$$2^{10} + 2^4$$

4 6 6 9 22 27 13 9 16 34 5 8 7 48 87 0 12 6 0 8 49

1 0 180 1101 10010 100 10010

V Tag Pg

V PN

0	1	5
1	0	13
2	0	D
3	1	6 14
4	1	9
5	1	11
6	0	D
7	1	4
8	0	15
9	0	D
10	1	3
11	1	12

TIB final

V	T	Pg
1	18	15
1	4	9
1	3	14
1	0	5

V	Tag	Pg
1	all	
1	11 18 0 4 3	12 8 5 9
1	7 18 1 0 4	14 15 9
1	3 18 1 0 4	12 15 9
0	3 7 11 0	6 14 15
	4 3	5 9 14
	4 3 7 11	6 14 15
	0 10	13 15

TIB/PT/F

1	PT
0	PT
4	PT
13	F
18	F
4	TB
18	TB

This one has fewer faults but the Change time per page is bigger.