Drew Pulliam DTP180003
CS 3340.004 Final

#1 Structural Hazard

#2 Pipelining

#3 Pipeline Data Hazard

#4 Temporal Locality

#5 Control

#6

$\frac{2227}{8\times1024} = 0.27$, tag = 0 TLB = miss, Page Table: valid bit = 1, page num = 5

$\frac{4669}{8192} = 0.57$, tag = 0 TLB = Hit

$\frac{13916}{8192} = 1.69$, tag = 1 TLB = miss, Page Table: valid bit = 0, page # = 24, page fault

$\frac{12608}{8192} = 1.54$, tag = 1 TLB = hit

$\frac{49225}{8192} = 6.01$, tag = 6 TLB = miss, Page Table: valid bit = 0, page # = 48, page fault

$\frac{39587}{8192} = 4.22$, tag = 4 TLB = miss, Page Table - valid bit = 1, page # = 9

$\frac{48870}{8192} = 5.96$, tag = 5 TLB = miss, Page Table = valid bit = 1, page # = 11

Page Table

Valid	Page #
1	5
1	24
0	Disk
1	6
1	9
1	11
1	48
1	4
0	Disk
0	Disk
1	3
1	12

TLB

Valid	Tag	Page #	LRU
1	4	9	1
1	5	11	0
1	1	24	3
1	6	48	2

Drew Pullian DTP180003
CS3340.004 Final

#8 2 word blocks = 3 bits offset
8 blocks = 3 bit index
because all of the given numbers fit inside 5 bits, the tag field is always zero

one-way set associative (direct-mapped)

Decimal	Binary	offset	index	tag	Hit/miss
21	10101	101	010	0	M
24	11000	000	011	0	M
21	10101	101	010	0	H
18	10010	010	010	0	H
15	01111	111	001	0	M
3	00011	011	000	0	M
15	01111	111	001	0	H
15	01111	111	001	0	H
14	01110	110	001	0	H

4-misses

two-way set associative

$\frac{2 \text{ blocks}}{2 \text{ way}} = 4 \text{ sets} = 2^2$ 2 bits index (tag = 0 s

Dec	Binary	offset	index	tag	Hit/miss
21	10101	101	10	0	M
24	11000	000	11	0	M
21	10101	101	10	0	H
18	10010	010	10	0	H
15	01111	111	01	0	M
3	00011	011	00	0	M
15	01111	111	01	0	H
15	01111	111	01	0	H
14	01110	110	01	0	H

4-misses

Drew Fullam DTF180003
CS 3340.004 Final

#8 continued

four-way set associative $\frac{8 \text{ blocks}}{4 \text{ way}} = 2 \text{ sets} = 2^1$ 1 bit index tag = 1 bit

Dec	Binary	offset	index	tag	Hit/miss
21	10101	101	0	1	M
24	11000	000	1	1	M
21	10101	101	0	1	H
18	10010	010	0	1	H
15	01111	111	1	0	M
3	00011	011	0	0	M
15	01111	111	1	0	H
15	01111	111	1	0	H
14	01110	110	1	0	H

4 misses

2-way set associative $\frac{8 \text{ blocks}}{8 \text{ way}} = 1 \text{ set} = 2^0$ 0 bit index tag = 2 real bits

Dec	Binary	offset	index	tag	H/M
21	10101	101	N/A	10	M
24	11000	000		11	M
21	10101	101		10	H
18	10010	010		11	H
15	01111	111		01	M
3	00011	011		00	M
15	01111	111		01	H
15	01111	111		01	H
14	01110	110		01	H

4 misses

Drew Pelham DTP 180003
CS 3340.004 Final

#9

sll $t0, $s0, 4 — R-format

0	0	16	16	4	0
0000 00	00 000	1 0000	10000	00100	000000

slt $t2, $0, $t0 — R-format

0	0	8	10	0	42
0000 00	00 000	0 1000	01010	00000	101 010

bne $t2, $0, ELSE — I-format

5	10	0	1
0001 01	01 010	00000	0000 0000 0000 0001

j DONE — J-format

2	2006
0 000 10	00 0000 0000 0010 0111 1101 0110

addi $t2, $t2, 2 — I-format

8	10	10	2
00 1000	01 010	01010	0000 0000 0000 0010

add $t2, $t2, $s0 — R-format

0	10	16	10	0	32
00 0000	01010	10000	01010	00000	10 0000

#10

263.3_{ten}

half-precision 0 01011 00000 11101

single 0 1000 0111 0000 0111 0100 1100 1100 110

double 0 100 0000 0111 0000 0111 0100 1100 1100 1100 1100 1100 1100 1100 1100 1101

#12

3 GHz = 3×10^9 cycles/sec

$P1 = 3\times10^9 \frac{\text{cycles}}{\text{sec}} \cdot \frac{1 \text{ instruction}}{2.5 \text{ cycles}} = 1.2\times10^9$ instructions/sec

$P2 = 3\times10^9 \frac{\text{cycles}}{\text{sec}} \cdot \frac{1 \text{ instruction}}{1 \text{ cycle}} = 3\times10^9$ instructions/sec

P2 has better performance

$P1 = 3\times10^9 \frac{\text{cycles}}{\text{sec}} \cdot 30 \text{ sec} = 9\times10^{10}$ cycles

$1.2\times10^9 \frac{\text{inst}}{\text{sec}} \cdot 30 \text{ sec} = 3.6\times10^9$ instructions

$P2 = 3\times10^9 \frac{\text{cycles}}{\text{sec}} \cdot 30 \text{ sec} = 9\times10^{10}$ cycles

$3\times10^9 \frac{\text{inst}}{\text{sec}} \cdot 30 \text{ sec} = 9\times10^{10}$ instructions