

T5.12 (12.1) (1) $1.5 + 0.07 \times 200 = 15.5$ $1.5 + 0.07 \times 400 = 29.5$ (90% ↑)
 (2) $1.5 + 0.07 \times (12 + 0.035 \times 200) = 2.83$ $1.5 + 0.07 \times (12 + 0.035 \times 400) = 3.32$ (17% ↑)
 (3) $1.5 + 0.07 \times (28 + 0.015 \times 200) = 3.61$ $1.5 + 0.07 \times (28 + 0.015 \times 400) = 3.88$ (5% ↑)

(12.2) 增加 L3 cache 减少了整体内存访问时间, 但占用了其他类型的资源;

(12.3) 多大的 cache 容量都不行,

$$\because 1.5 + 0.07 \times (50 + X \times 200) < 2.83$$

$$= 5$$

T5.14 (14.1) 至少 9 位

(14.2) (12.64) $\frac{12.5}{1.4} = 8.9$ (12.64) 更好

(136, 128) $\frac{120}{0.73} = 9.6$

(14.3) 有错, 应为 0x3b5

T5.16 (16.1)

Address	virtual page	TLB H(1)/M(0)	TLB		
			valid	tag	physical page
	a		1	b	12
4669	1	TLB (0)	1	7	4
0x123d		PT (1)	1	3	6
		PF	1 → 0	1	13
2227	0	TLB (0)	1 → 1	0	5
0x08b		PT (1)	1	7	4
			1 → 1	3	6
1391b	3	TLB (1)	1 → 1	0	5
0x365c		PT (0)	1	7	4
			1 → 2	3	6
34587	8	TLB (0)	1 → 1	0	5
0x871b		PT (1)	1 → 3	8	14
			1 → 2	3	6
48870	b	TLB (0)	1 → 1	0	5
0xbec6		PT (1)	1 → 3	8	14
			1 → 2	3	6
			1 → 4	11	12

12608	3	TLB (1)	1 → 1	0	5
0x3140		PT (1)	1 → 3	8	14
			1 → 5	3	6
			1 → 4	b	12
49225	c	TLB (0)	1 → 6	c	15
0xc040		PT (0)	1 → 3	8	14
		PF	1 → 5	3	6
			1 → 4	b	12

(5.16.2)

Address	virtual page	TLB H(1)/M(0)	TLB		
			valid	tag	physical page
4669 0x123d	1	TLB (0) PT (1)	1 1 1 1 → 0	11 7 3 0	12 4 6 5
2227 0x08b3	0	TLB (0) PT (1)	1 1 1 1 → 1	11 7 3 0	12 4 6 5
1396 0x3b5c	3	TLB (1) PT (1)	1 1 1 1 → 2	11 7 3 0	12 4 6 5
34587 0x871b	8	TLB (0) PT (1) PF	1 → 3 1 1 2	2 7 3 0	13 4 6 5
48870 0xb6eb	11	TLB (0) PT (1)	1 → 4 1 1 1 → 2	2 7 3 0	13 4 6 5
12608 0x3140	3	TLB (1) PT (1)	1 → 4 1 1 5	2 7 3 0	13 4 6 5
1249125 0xc040	12	TLB (0) PT (1)	1 → 4 1 1 → 6 1 → 5	2 7 3 0	13 4 6 5

(5.6.3)

Address	virtual page	TLB H(1)/M(0)	tag	index	TLB			
					valid	tag	physical page	index
4669 0x123d	1	TLB (0) PT (1)	0	1	1 1 1 1 → 0	6 7 3 0	12 4 6 13	0 1 0 1
2227 0x08b3	0	TLB (0) PT (1)	0	0	1 → 1 1 1 1 → 0	0 7 3 0	5 4 6 13	0 1 0 1
1391b 0x365c	3	TLB (0) PT (1)	1	1	1 → 1 1 → 2 1 1 → 0	0 1 3 1	5 6 6 13	0 1 0 1
34587 0x871b	8	TLB (0) PT (1)	4	0	1 → 1 1 → 2 1 → 3 1 → 0	0 1 4 1	5 6 14 13	0 1 0 1
48870 0xb6eb	b	TLB (0) PT (1)	5	1	1 → 1 1 → 2 1 → 3 1 → 4	0 1 4 5	5 6 14 12	0 1 0 1
12608 0x3140	3	TLB (1) PT (1)	1	1	1 → 1 1 → 5 1 → 3 1 → 4	0 4 5	5 6 14 12	0 1 0 1
49225 0xc040	c	TLB (0) PT (0) PF	6	0	1 → 6 1 → 5 1 → 3 1 → 4	6 4 5	15 6 14 12	0 1 0 1

(5.b.4)

Address	virtual page	TLB H(1)/M(0)	tag	index	TLB			
					valid	tag	physical page	index
4669 0x123d	1	TLB (0) PT (1) PF	0	1	1 1 1 0	b 0 3 4	12 13 6 9	0 1 2 3
227 0x08b3	0	TLB (0) PT (1)	0	0	1 1 1 0	0 0 3 4	5 13 6 9	0 1 2 3
1391b 0x365c	3	TLB (0) PT (1)	0	3	1 1 1 1	0 0 3 0	5 13 6 6	0 1 2 3
34587 0x871b	8	TLB (0) PT (1) PF	2	0	1 1 1 1	2 0 3 0	14 13 6 6	0 1 2 3
48870 0xb2eb	b	TLB (0) PT (1)	2	3	1 1 1 1	2 0 3 2	14 13 6 6	0 1 2 3
12b08 0x3140	3	TLB (1) PT (1)	0	3	1 1 1 1	2 0 3 0	14 13 6 6	0 1 2 3
49225 0xc049	c	TLB (0) PT (0) PF	3	0	1 1 1 1	3 0 3 0	15 13 6 6	0 1 2 3

(5.b.5) 没有TLB, 每个内存访问都要对RAM进行两次访问。

15.17 (17.1) 可知 tag size 为: $32 - \log_2(8192) = 19 \text{ bits}$

$$\text{总大小: } 5 \times (2^{19} \times 4) = 10 \text{ MB}$$

(17.2) 总: $2048 \times 8 = 16 \text{ MB}$

min: 3840 bytes

max: 7680 bytes

(17.3) 不能,
通过减小序号数量来实现,

T5.20 (20.1) 没有命中

(20.2)

0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0
M	M	M	M	M	M	M	M	H	H	M	M	M	M	H	H	M

(20.3) 4

(20.4) MRU ,

0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0

(20.5) 缓存控制器无法预测未来的变化,

(20.6) 选择会发生冲突的地址选择不缓存可有效提升 miss rate

T5.21 (21.1) ① $\text{CPI} = 1.5 + 120/10000 \times (15 + 175) = 3.78$

② $\text{VMM} \uparrow$ $\text{CPI} = 1.5 + 120/10000 \times (15 + 350) = 5.88$

③ $\text{VMM} \times \frac{1}{2}$ $\text{CPI} = 1.5 + 120/10000 \times (15 + 87.5) = 2.73$

④ $\text{CPI} = 1.5 + 120/10000 \times 15 = 1.62$

$$1.5 + 120/10000 \times (15 + 7) < 1.1 \times 1.68$$

$\Rightarrow 14 \text{ cycles}$

(21.2) ① $\text{CPI} = 1.5 + 120/1000 \times 15 + 30/10000 \times 1100 = 4.98$

② $\text{CPI} = 1.5 + 120/1000 \times (15 + 175) + 30/10000 \times (1100 + 175) = 7.6$

③ 减半 $\left\{ \begin{array}{l} \text{非虚拟化: } \text{CPI} = 1.5 + 120/10000 \times 15 + 15/10000 \times 1100 = 3.33 \\ \text{虚拟化: } \text{CPI} = 1.5 + 120/10000 \times (15 + 175) + 15/10000 \times (1100 + 175) = 5.69 \end{array} \right.$

T5.22

虚拟化: $CP1 = 1.5 \times 120 / 1000 \times (15 + 15) + 15 / 1000 \times (1120 + 115) = 5.07$

T5.29

(29.1) 影子表: (1) VM创建页面表

(2) ——

(3) VM拦截页面故障

(4) VM嵌套页面表

嵌套页表: (1) VM创建新页面

(2) 硬件跟踪两个页面, 将VA转为MA;

(3) VM更新页面表, 使旧TLB失效;

(4) VM嵌套页面表

(29.2) 4; 24

(29.3) 缺页率,
TLB缺失率;

(29.4) 1.03;
1.04

(29.5) 合并页表更新;

(29.6) NPT缓存