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Exercise 7.1.1:

(a)

0 : 0000 → (p,w) (0,0)

p1:
PT starts at 4 in p1, p value is 0
p: 4 + 0 = 4
content of 4 in p1 : -45, w value is 0
w : -45 + 0 = -45
contents of -45 : page fault

p2:
PT starts at 12 in p2, p value is 0
p: 12 + 0 = 12
content of 12 in p2 : 0, w value is 0
w : 0 + 0 = 0
contents of 0 : 6

1 : 0001 → (p,w) (0,1)

p1:
PT starts at 4 in p1, p value is 0
p: 4 + 0 = 4
content of 4 in p1 : -45, w value is 1
w : -45 + 1 = -45
contents of -44 : page fault

p2:
PT starts at 12 in p2, p value is 0
p: 12 + 0 = 12
content of 12 in p2 : 0, w value is 1
w : 0 + 1 = 1
contents of 1 : 15

4 : 0100 → (p,w) (4,0)
p1:
PT starts at 4 in p1, p value is 4
p: 4 + 4 = 8
content of 8 in p1 : 9, w value is 0
w : 9 + 0 = 9
contents of 9 : -3

p2:
PT starts at 12 in p2, p value is 4
p: 12 + 4 = 16
content of 16 in p2 : 0, w value is 0
w : 0 + 0 = 0
contents of 0 : 6

5 : 0101 → (p,w) (4,1)
p1:
PT starts at 4 in p1, p value is 4
p: 4 + 4 = 8
content of 8 in p1 : 9, w value is 1
w : 9 + 1 = 10
contents of 10 : 8

p2:
PT starts at 12 in p2, p value is 4
p: 12 + 4 = 16
content of 16 in p2 : 0, w value is 1
w : 0 + 1 = 1
contents of 1 : 15

8 : 1000 → (p,w) (8,0)
p1:
PT starts at 4 in p1, p value is 8
p: 4 + 8 = 12
content of 12 in p1 : 0, w value is 0
w : 0 + 0 = 0
contents of 0 : 6

p2:
PT starts at 12 in p2, p value is 8
p: 12 + 8 = 20
content of 20 in p2 : 0, w value is 0
w : 0 + 0 = 0
contents of 0 : 6

10 : 1010 → (p,w) (8,2)
p1:
PT starts at 4 in p1, p value is 8
p: 4 + 8 = 12
content of 12 in p1 : 0, w value is 2
w : 0 + 2 = 2
contents of 2 : 3

p2:
PT starts at 12 in p2, p value is 8
p: 12 + 8 = 20
content of 20 in p2 : 0, w value is 2
w : 0 + 2 = 2
contents of 2 : 3

12 : 1100

→ (p,w) (12,0)
p1:
PT starts at 4 in p1, p value is 12
p: 4 + 12 = 16
content of 16 in p1 : 0, w value is 0
w : 0 + 0 = 0
contents of 0 : 6

p2:
PT starts at 12 in p2, p value is 12
p: 12 + 12 = 24
content of 24 in p2 : 5, w value is 0
w : 5 + 0 = 5
contents of 5 : 8

15 : 1111

→ (p,w) (12,3)
p1:
PT starts at 4 in p1, p value is 12
p: 4 + 12 = 16
content of 16 in p1 : 0, w value is 3
w : 0 + 3 = 3
contents of 3 : -2

p2:
PT starts at 12 in p2, p value is 12
p: 12 + 12 = 24
content of 24 in p2 : 5, w value is 3
w : 5 + 3 = 8
contents of 8 : 9

Exercise 7.1.4:

(a)

32 : 28 → page table of segment s
33 : 48 → page p of segment s
34 : - → free
35 : 60 → page p of segment s
36 : 56 → page p of segment s
37 : - → free
38 : - → free
39 : - → free
40 : 24 → page table of segment s
41 : - → free
42 : - → free
43 : - → free
44 : 40 → page table of segment s
45 : 20 → page table of segment s
46 : - → free
47 : - → free
48 : 16 → page p of the segment table
49 : - → free
50 : - → free
51 : 36 → page table of segment s
52 : 120 → page table of segment s
53 : 16 → page p of the segment table
54 : 16 → page p of the segment table
55 : 27 → page table of segment s
56 : 52 → page p of segment s
57 : 47 → page p of segment s
58 : -1 → not resident in memory (load from disk)
59 : 3 → page table of segment s
60 : 44 → page p of segment s
61 : - → free
62 : - → free
63 : - → free

(b)

Virtual address: 113

113 into binary : 01 11 00 01
(s1, s2, p, w) → (1,3,0,1)

The offsets are used to trace through the hierarchy starting with the page table of the segment table at address 32

Physical address (w=1) : 48

(c)

Virtual address 68
68 into binary : 01 00 01 00
(s1, s2, p, w) → *(1,0,1,0)*
Physical address (w=0) : 28
(Not sure how to implement the changes as a result of the translation?)

(d)

- Deleting segment 7, results in the deletion of physical memory 3, which has an effect on block content 1, which holds in p1 page table 3 (?)

Exercise 7.1.5:

(a)

There is not a single mention of 'TLB' in this chapter, and no explanation what is being referred to?

So my guess is that this is 'Translation Lookaside Buffer' from chapter 6?

➔ *"When a logical address (s, p, w) has been translated to a physical address (f, w), the TLB saves the frame number f together with the address component (s, p). When another address in the same segment and page, (s, p, w'), is to be translated, the TLB retrieves the frame number f associated with (s, p) without any memory access. The new offset w' is then added to f to form the physical address."*

With that in mind, the following addresses would find a match in the TLB:
Frame address 4: 16,17,3
Frame address 52: 16

(b)

- Page fault: 3
- Error: 17, 64, 65, 66

Exercise 7.2.2:

(a)

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RS		**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Frame 0	0	0	0	0	0	0	0	0	0	0	0	~~0~~	4	4	4
Frame 1	1	1	~~1~~	4	4	4	4	4	1	1	1	1	1	1	1
Frame 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
Frame 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pg fault				*					*				*		

(b)

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RS		**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Frame 0	**0**	**0**	**0**	4	4	4	4	4	4	4	**4**	3	3	3	3
Frame 1	1	1	1	**1**	0	0	0	0	0	0	0	**0**	4	4	4
Frame 2	2	2	2	2	**2**	**2**	**2**	**2**	1	1	1	1	**1**	**1**	**1**
Frame 3	3	3	3	3	3	3	3	3	**3**	**3**	2	2	2	2	2
Pg fault				*	*				*		*	*	*		

(c)

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RS		**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Frame 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frame 1	1	1	1	1	1	~~1~~	3	3	3	3	3	3	3	3	3
Frame 2	2	2	~~2~~	4	4	4	4	4	1	1	1	~~1~~	4	4	4
Frame 3	3	3	3	3	~~3~~	2	2	2	2	2	2	2	2	2	2
Pg fault				*		*	*		*				*		
Q head	3	0	1	4	0	2	3	0	1	0	2	3	4	2	3
	2	3	0	1	4	0	2	3	0	1	0	2	3	4	2
	1	2	3	0	1	4	0	2	3	3	1	0	2	3	4
	0	1	2	3	3	1	4	4	2	2	3	1	0	0	0

Exercise 7.3.1:

(a)

		d0	d1	d2	d3	d4	d5	d6	d7		
Resident	**aging**	**aging**	**aging**	**aging**	**aging**	**aging**	**aging**	**aging**	**aging**		
Page 0	00 00 00	00 00 00	00 00 00	10 00 00	11 00 00	11 10 00	01 11 00	00 11 10	00 01 11	-->	7
Page 1	00 00 00	00 00 00	10 00 00	01 00 00	00 10 00	00 01 00	00 00 10	00 00 01	10 00 00	-->	32
Page 2	00 00 00	00 00 00	10 00 00	01 00 00	00 10 00	00 01 00	10 00 10	11 00 01	01 10 00	-->	24
Page 3	00 00 00	10 00 00	01 00 00	00 10 00	10 01 00	01 00 10	00 10 01	00 01 00	00 00 10	-->	2 replaced
		reference	reference	reference	reference	reference	reference	reference	reference		
		3	1 2	0	0 3	0	2	2	1		

Exercise 7.3.2:

(a)

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RS		**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Frame 0	**0 | 0**	**0 | 1**	**0 | 1**	0 | 0	0 | 1	**0 | 1**	0 | 0	0 | 1	0 | 0	0 | 1	0 | 1	0 | 1	**0 | 0**	2 | 1	2 | 1
Frame 1	1 | 0	1 | 0	1 | 1	1 | 0	1 | 0	1 | 0	3 | 1	3 | 1	3 | 0	3 | 0	3 | 0	3 | 1	3 | 0	**3 | 0**	**3 | 1**
Frame 2	2 | 0	2 | 0	2 | 0	4 | 1	4 | 1	4 | 1	**4 | 1**	**4 | 1**	1 | 1	1 | 1	1 | 1	1 | 1	1 | 0	1 | 0	1 | 0
Frame 3	3 | 0	3 | 0	3 | 0	**3 | 0**	**3 | 0**	2 | 1	2 | 1	2 | 1	**2 | 0**	**2 | 0**	**2 | 1**	**2 | 1**	4 | 1	4 | 1	4 | 1
Pg fault				*		*	*		*				*	*	

(b)

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RS		**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Page 0	**0 | 00**	**0 | 10**	**0 | 10**	0 | 00	0 | 10	**0 | 10**	3 | 10	3 | 10	3 | 10	3 | 10	3 | 10	3 | 10	**3 | 00**	2 | 10	2 | 10
Page 1	1 | 00	1 | 00	1 | 11	1 | 01	1 | 01	1 | 01	**1 | 00**	0 | 10	0 | 10	0 | 10	0 | 10	0 | 10	0 | 00	**0 | 00**	3 | 10
Page 2	2 | 00	2 | 00	2 | 00	4 | 10	4 | 10	4 | 10	4 | 00	**4 | 00**	1 | 11	1 | 11	1 | 11	1 | 11	1 | 01	1 | 01	**1 | 01**
Page 3	3 | 00	3 | 00	3 | 00	**3 | 00**	**3 | 00**	2 | 10	2 | 00	2 | 00	**2 | 00**	**2 | 00**	**2 | 10**	**2 | 10**	4 | 10	4 | 10	4 | 10
Pg fault				*		*	*	*	*				*	*	*

Exercise 7.4.1:

(a)

d = 3

Time	t1			t2			t3			t4				
RS	**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Optimal	0	0	0	0	0	0	0	0	0	2	2	2		
working	1	1	2	2	2	1	1	1	2	3	3	3		
set	4	4	4	3	3	3		2	3	4	4	4		
Pg fault	*		*	*		*	*	*	*	*				
Size	3	3	3	3	3	3	2	3	3	3	3	3		

(b)

d = 3

Time t	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11
RS	**0**	**1**	**4**	**0**	**2**	**3**	**0**	**1**	**0**	**2**	**3**	**4**	**2**	**3**
Page 0	x	x	x	x	x	x	x	x	x	x	x	-	-	-
Page 1	-	x	x	x	-	-	-	x	x	x	-	-	-	-
Page 2	-	-	-	-	x	x	x	-	-	x	x	x	x	x
Page 3	-	-	-	-	-	x	x	x	-	-	x	x	x	x
Page 4	-	-	x	x	x	-	-	-	-	-	-	x	x	-
Pg fault	*	*	*		*	*		*		*	*	*		
WS size	1	2	3	3	3	3	3	3	2	3	3	3	3	2

Exercise 7.4.2:

(a)

d = 3														
Time t	0	1	2	3	4	5	6	7	8	9	10	11	12	13
RS	**0**	**1**	**4**	**0**	**2**	**0**	**0**	**1**	**0**	**3**	**0**	**4**	**0**	**3**
Page 0	x	x	x	x	-	x	x	x	x	x	x	x	x	x
Page 1	-	x	x	x	-	-	-	x	x	x	x	-	-	-
Page 2	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Page 3	-	-	-	-	-	-	-	-	-	x	x	x	x	x
Page 4	-	-	x	x	x	x	x	-	-	-	-	x	x	x
Pg fault	*	*	*		*	*		*		*		*		
Size	1	2	3		2	3	3	2	2	3	3	3	3	3

Exercise 7.5.1:

(a)

$$E = (1 - P) * m + P * S$$

P = ??	200 = (1-P) * 100 + P * ((5*0.2+15*0.8) / 2)
E = 200 ns	200 = 100 – 100P + P * ((1+12)/2)
m = 100 ns	200 = 100 – 100P + P * 6.5
S = 5 ms (free page frame available)	200 – 100 = -100P + 6.5P
S = 15 ms (no free frame available)	100 = -93.5P
Free frame available 20% of the time.	P = 100 / -93.5 = - 1.06952

Maximum page fault rate : 6.952%

Exercise 7.5.3:

(a)

Page fault service time : 10^7 ns (f*S?)
Average memory access time : 100 ns (t*m?)
Page fault every 1,000,000 memory access

Mean time between page faults (L) = time it takes to service each page fault (S)
L = S = 110 / 1,000,000 (???)

(b)

- I don’t know, through the material of this chapter / examples given / illustrations shown, how to do this…
