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217034041 mutex semP / semQ, semX

1) P-lock() {  
wait(semP);  
countP = countP + 1;  
if countP == 1 then  
wait(semX);  
signal(semP);  
}

P-unlock() {  
wait(semP);  
countP = countP - 1;  
if countP == 0  
signal(semX);  
signal(semP);  
}

Q-lock() {  
wait(semQ);  
countQ = countQ + 1;  
if countQ == 1 then  
wait(semX);  
signal(semQ);  
}

Q-unlock() {  
wait(semQ);  
countQ = countQ - 1;  
if countQ == 0 then  
signal(semX);  
signal(semQ);  
}

2)  $(1,0) \dots (1,14)$

$(2,0) \quad (2,14)$

$(3,0) \quad (3,14)$

$(6,0) \dots (6,14)$  X

7  $\rightarrow 13$

8  $\rightarrow 12$

9  $\rightarrow 11$

10  $\rightarrow 10$

11  $\rightarrow 9$

12  $\rightarrow 8$

15

14

6

90

14

13

12

11

10

9

159

3)

P1 starts

A: 0 B: 1 C: 1

P3 runs A: 1 B: 1 C: 2

P5 runs A: 2 B: 2 C: 2

P4 runs A: 2 B: 3 C: 2

P2 & P4 can't finish! Deadlock

4) a) Page is  $2^{14}$  1/4 bit offset

$$36 - 1/4 = 22$$

$$3 \times 2^{22} \times 8 = 96 \text{ MB}$$

b)

$$\frac{2^{12}}{2^{11}} + \frac{2^{11}}{2^{11}} + \frac{2^{13}}{2^{11}} + \frac{2^{12}}{2^{11}} + \frac{2^{11}}{2^{11}} \times 2 = 11$$

3 outer tables  $11 + 3 = 14$ 

$$8 \times 14 \times 2^{11} = 224 \text{ KB}$$



c)  $\frac{46B}{16KB} = \frac{2^{32}}{2^{14}} = 2^{18} \quad 2^{18} \times 8 = 2MB$

5)

<div style="border: 1px solid black; padding: 2px;">3</div>	<div style="border: 1px solid black; padding: 2px;">8 <del>7</del></div>	<div style="border: 1px solid black; padding: 2px;">3 <del>7</del> 4</div>	<div style="border: 1px solid black; padding: 2px;">3 <del>7</del> 4 <del>2</del></div>	<div style="border: 1px solid black; padding: 2px;"><del>7</del> <del>4</del> 2 <del>5</del></div>	<div style="border: 1px solid black; padding: 2px;">7 <del>4</del> 5 <del>2</del></div>	<div style="border: 1px solid black; padding: 2px;"><del>4</del> 5 <del>2</del> 1</div>
<div style="border: 1px solid black; padding: 2px;">5 <del>2</del> 1 <del>4</del></div>	<div style="border: 1px solid black; padding: 2px;">2 <del>1</del> 4 <del>5</del></div>	<div style="border: 1px solid black; padding: 2px;">1 <del>4</del> 5 <del>8</del></div>	<div style="border: 1px solid black; padding: 2px;">4 <del>5</del> 8 <del>1</del></div>	<div style="border: 1px solid black; padding: 2px;">4 <del>5</del> <del>1</del> <del>8</del></div>	<div style="border: 1px solid black; padding: 2px;"><del>5</del> <del>1</del> 8 <del>3</del></div>	<div style="border: 1px solid black; padding: 2px;">1 <del>8</del> <del>3</del> <del>5</del></div>
<div style="border: 1px solid black; padding: 2px;">3 <del>1</del> 5 <del>1</del> <del>2</del></div>	<div style="border: 1px solid black; padding: 2px;">3 <del>1</del> 8 <del>5</del></div>	<div style="border: 1px solid black; padding: 2px;">1 <del>8</del> <del>5</del> 2</div>	<div style="border: 1px solid black; padding: 2px;">8 <del>5</del> <del>2</del> <del>2</del></div>	<div style="border: 1px solid black; padding: 2px;">8 <del>3</del> <del>2</del> <del>5</del></div>	<div style="border: 1px solid black; padding: 2px;">2 <del>3</del> <del>5</del> <del>4</del></div>	<div style="border: 1px solid black; padding: 2px;">11</div>

[illegible]

4  
5  
9  
9

9

C)

3	3	3	3	5	5	5	5	5	5	3	5	5	5	5	5	3	3	2	2	2	2
7	7	7	7	7	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	3
		4	4	4	4	4	4	4	4	8	8	8	8	8	8	8	8	8	8	8	4
		2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3

9 9

11

3	3	3	5	3	5	5	5	5	5	5	5	5	5	5	5	3	2	2	2	2	4
7	7	7	7	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	5
		4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

10

3	3	3	5	3	5	5	5	5	5	3	3	3	3	3	5	5	5	5	5	5	5
7	7	7	7	7	7	1	1	1	1	8	8	8	8	8	8	8	8	8	8	8	4
		4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	3	3
		2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	2	2	2

11



$$7) a) \frac{2^{36}}{2^{14}} = 2^{22} \quad 2^{22} \text{ fat entries}$$

$$\text{Fat size} = 8 \times 2^{22} = 32 \text{ MB}$$

$$\frac{2^{25}}{2^{14}} = 2^{11} \text{ fat blocks}$$

$$\text{max mem size} = 64 \text{ GB} \quad \text{Fat size} = 32 \text{ MB}$$

$$\text{max file size} = \underline{64 \text{ GB} - 32 \text{ MB}}$$

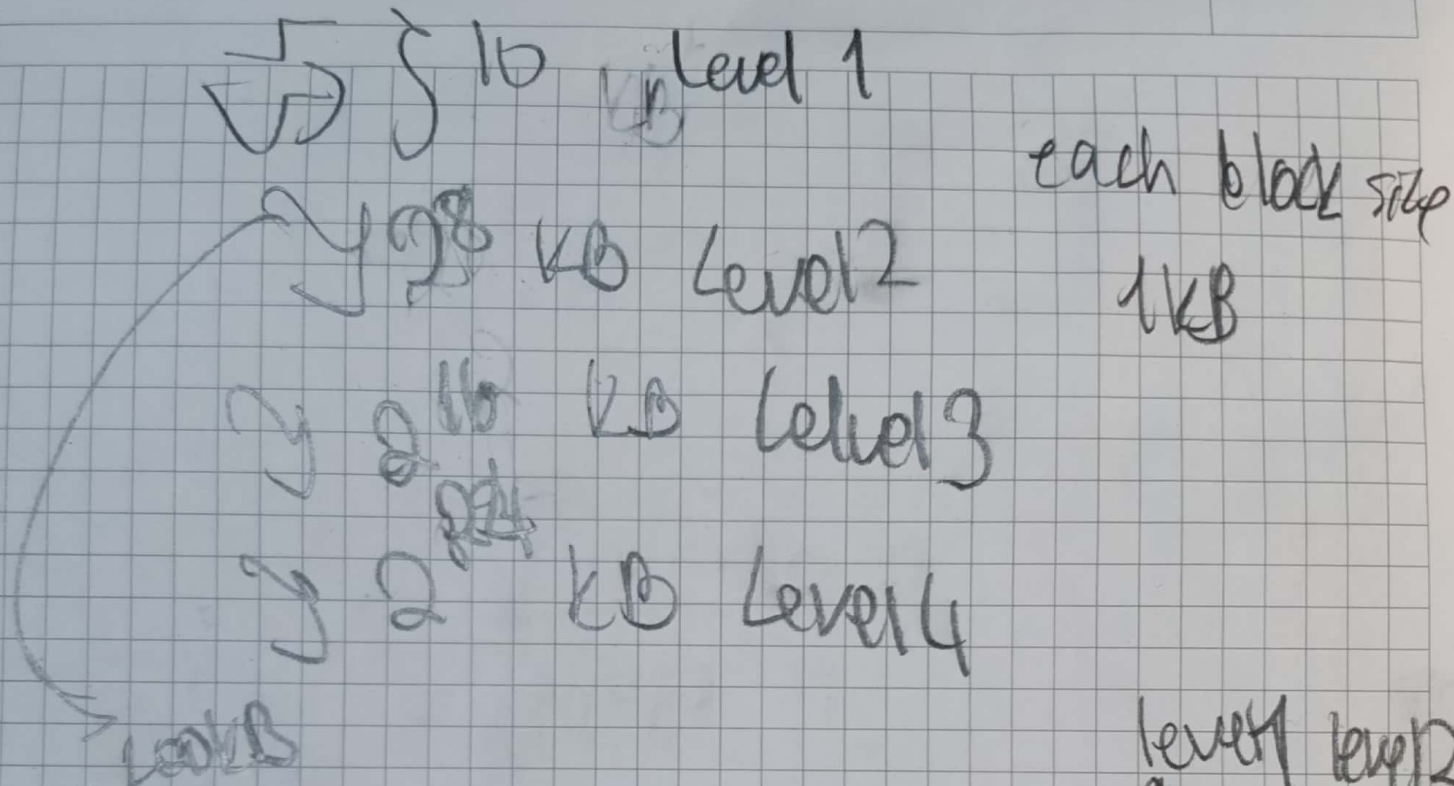
b) Two level index files

$$\left( \frac{2^{14}}{2^3} = 2^{11} \right)^2 = 2^{22}$$

blocks exist in per file

$$2^{22} \times 2^{14} = \underline{64 \text{ GB}}$$

8)



So A: Single index block

B:  $2^7 = 128$  KB, remove half or double indirect, so

C:  $2^{30}$  KB

$\frac{2^{30}}{2^8} = 2^{12}$  single indirect blocks

1 indirect  $\rightarrow 256$  KB

Level 1 Level 2

$1 + 1 + 2^7 = 130$  index blocks