

CS-341

Virtual Memory Assignment

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(Q1)

Given, A 46-bit Virtual Address Space, 32 bit Physical Space

ie) 2^{46} bytes space is to be covered by 32 bit space

Let Table size be 2^x bytes (Page size is 2 bits)

\Rightarrow No. of entries in Table T1 = Size of Table / Size of entry

$$\Rightarrow 2^x \text{ bytes} / 4 \text{ bytes} = \underline{\underline{2^{x-2}}}$$

Each of this entry correspond to another Table in T2 layer.

$$\text{ie) } \underline{\text{Size of T2}} = \underset{\substack{\uparrow \\ \text{No. of Tables}}}{2^{x-2}} \times \underset{\substack{\uparrow \\ \text{Table size}}}{2^x}$$

$$\begin{aligned} \underline{\text{No. of Entries in T2}} &= \text{Size of T2} / \text{Size of entry} \\ &= 2^{2x-2} / 4 = 2^{2x-6} \end{aligned}$$

$$\text{Similarly, No. of pages in T3} = \underline{\underline{2^{3x-6}}}$$

Memory size \uparrow 46

Table size \uparrow x

$$\begin{aligned} \text{No. of Tables required for Virtual memory} &\Rightarrow 2^{46} / 2^x \\ &\Rightarrow 2^{3x-6} = 2^{46-x} \Rightarrow 4x = 52 \Rightarrow \boxed{x=13} \Rightarrow \boxed{8KB} \end{aligned}$$

Q2) Given, Memory Access Time = 20 ns

Page Fault Service time = 10 ms

Page Fault Rate = $1/10^6$

$$\begin{aligned} \text{Effective Memory Access Time} &= \frac{(\text{page fault rate})}{\times} \\ &\quad (\text{page fault service time}) \\ &\quad + \\ &\quad (\text{success rate}) \\ &\quad \times \\ &\quad (\text{Memory access time}) \end{aligned}$$

$$\Rightarrow \frac{1}{10^6} \times 10 \times 10^6 \text{ ns} + 20 \times 10^9 \text{ ns}$$

$$\Rightarrow 10 + 20 = \boxed{30 \text{ ns}}$$

(Q3)

Given,

Virtual Address size = 32 bits

Physical Address size = 36 bits

Physical Memory size = 2^{36} bytes

Page frame size = 4KB = 2^{12} bytes

No. of page frames required to access physical memory

$$= \frac{2^{36}}{2^{12}} = 2^{24}$$

Total memory pagesize

∴ Third level of page table requires 24 bits

In both first and second levels, 9 bits are used to access next level. And each page size is 4 bytes

$$\Rightarrow 2^9 \times 4 = 2^{11} \text{ bytes (size of next level)}$$

⇒ There are $\frac{2^{36}}{2^{11}}$ possible locations to store this table

Physical memory Required Table

∴ Therefore we need 25 bits for both 1st, 2nd Table

25, 25, 24

Q4)

X	X	X	X	3	3	3	3	3	3	3	
X	X	2	2	2	7	4	5	6	6	6	
X	1	1	1	1	1	1	1	1	1	1	
	X	X	✓	X	X	X	X	X	✓	✓	

∴ There are total 7 page faults

Q5)

$$\text{Effective memory Access Time} = \frac{(\text{TLB Hit Ratio})}{\times}$$

$$(\text{TLB Access Time} + \text{Memory Access Time})$$

+

$$\frac{(\text{TLB Miss Ratio})}{\times}$$

$$(\text{TLB Access Time} + \text{Page Table Access Time} + \text{Memory Access Time})$$

$$\Rightarrow 0.6(10\text{ms} + 80\text{ms}) + 0.4(10 + 80 + 80)$$

$$= 0.6 \times 90 + 0.4 \times 170$$

$$54 + 68$$

$$\Rightarrow \boxed{122 \text{ ms}}$$