GATE CSE 2020 | Question: 53

flat page table

35

Consider a paging system that uses 1-level page table residing in main memory and a TLB for address translation. Each main memory access takes 100 ns and TLB lookup takes 20 ns. Each page transfer to/from the disk takes 5000 ns. Assume that the TLB hit ratio is 95%, page fault rate is 10%. Assume that for 20% of the total page faults, a dirty page has to be written back to disk before the required page is read from disk. TLB update time is negligible. The average memory access time in ns (round off to 1 decimal places) is __________

flat page table , TLB

https://gateoverflow.in/333178/gate-cse-2020-question-53

1. Main Memory access time: 100 ns
2. TLB lookup time: 20 ns
3. Time to transfer one page to/from disk: 5000 ns
4. TLB hit ratio: 0.95
5. Page fault rate: 0.10
6. 20 % of page faults needs to be written back to disk

$$\underline{EMAT} = \underset{\text{TLB hit rate}}{0.95}\left(\overset{\text{TLB}}{20} + \overset{\text{MM}}{100}\right) + \overset{\text{TLB miss rate}}{0.05}\left(\overset{\text{TLB}}{20} + \overset{\text{page table MM}}{100} + \overset{\text{MM}}{100} + 0.90\,(0) + \underset{\text{page fault}}{0.10}\left(\underset{\text{page is NOT dirty}}{0.80}\left(\overset{5000}{\;}\right) + \underset{\text{page is dirty}}{0.20}\left(\overset{5000+5000}{\;}\right)\right)\right)$$

<TLB>

hit → (PA) → MM → $\boxed{\text{Done}}$

miss → page table in MM → PA → MM

No page fault → Done

(Read) One I/O operation

page fault → Dirty page

No → go to HDD transfer DONE

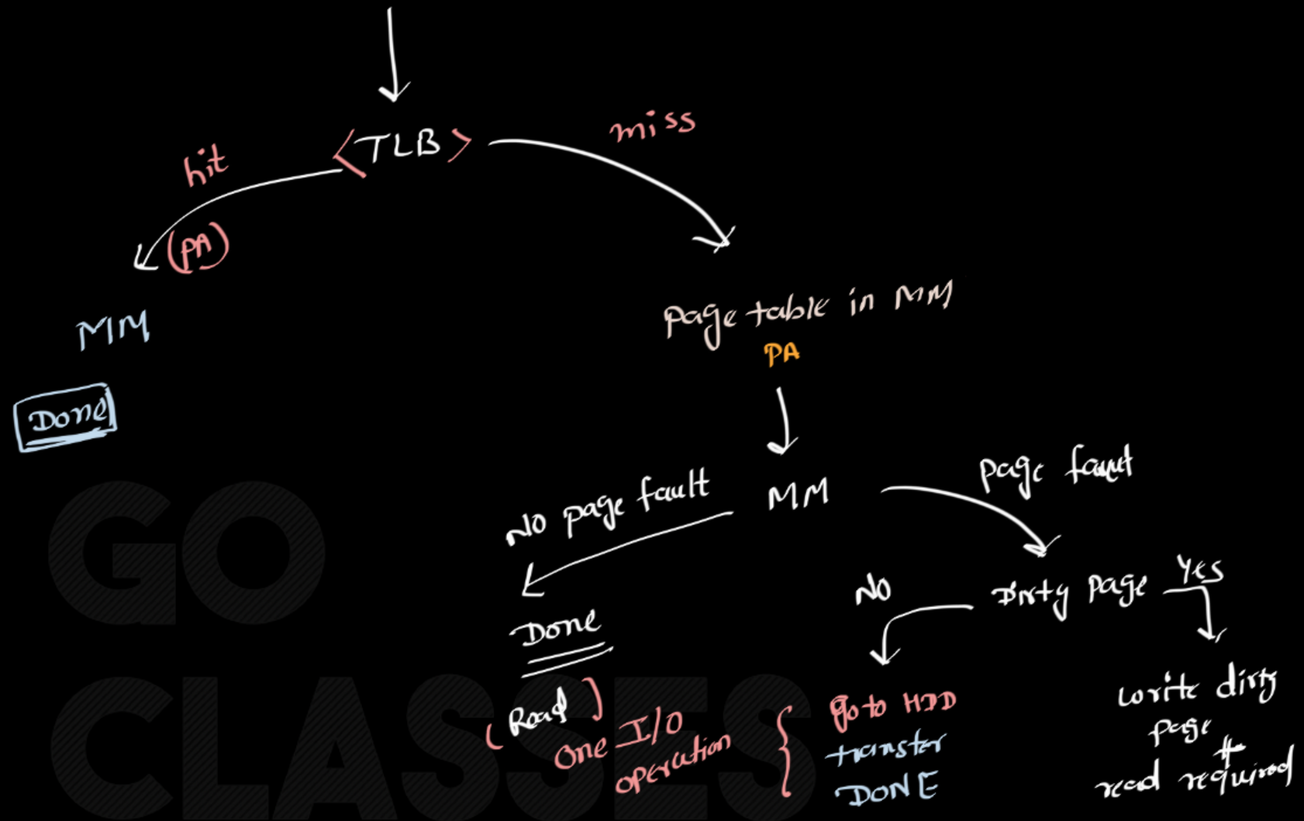
Yes → write dirty page + read required

1. Main Memory access time: 100 ns
2. TLB lookup time: 20 ns
3. Time to transfer one page to/from disk: 5000 ns
4. TLB hit ratio: 0.95
5. Page fault rate: 0.10
6. 20 % of page faults needs to be written back to disk

$$EMAT = 20 + \underbrace{0.95\,(100)}_{\text{TLB hit}} + \underbrace{0.05\,(100 + \overbrace{100}^{\text{for page table}} + \overbrace{\qquad}^{\text{Page fault time}})}_{\text{TLB miss}}$$

$$\text{Page fault dealtime} = 0.90\,(0) + 0.10\,(0.80\,(5000) + 0.20\,(5000 + 5000))$$

1. Main Memory access time: 100 ns
2. TLB lookup time: 20 ns
3. Time to transfer one page to/from disk: 5000 ns
4. TLB hit ratio: 0.95
5. Page fault rate: 0.10
6. 20 % of page faults needs to be written back to disk



$$20 + 100 + 0.05\left(100 + 0.10\left(5000 + 0.20 \times 5000\right)\right)$$

page fault

85

Best answer

Given,

1. Main Memory access time: 100 ns
2. TLB lookup time: 20 ns
3. Time to transfer one page to/from disk: 5000 ns
4. TLB hit ratio: 0.95
5. Page fault rate: 0.10
6. 20 % of page faults needs to be written back to disk

Hence, effective memory access time =

$$0.95(20+100)+0.05\{0.90(20+100+100)+0.10[0.80(20+100+5000+100)\ +0.20(20+100+5000+5000+100)]\}$$

$= 155.0$ ns

Explanation:

If there is a TLB hit, you just need to access the memory. If there is a miss 1 TLB lookup was wasted,

1. You need to lookup the page table for the entry and then access the required location, requiring 2 memory accesses - Assuming No Page fault occurs.
2. If there is a page fault, Then 1 memory access was wasted (you can only know that the page is not present in memory by checking the corresponding page entry in the page table). 80 % of the time, you'll only be fetching a page from secondary storage which takes 5000 ns, 20% of the time, you'll need to write a dirty page back to disk and bring the page (which caused the page fault) back to main memory, requiring $5000+5000$ ns

d3ba