3. Computer A with 4GHz run program x in 10 sec

Computer B run program x in 6 sec

Clock rate (F) can be increased a lot, but it will need the program to run 1.2times of the number of clock cycle(N) that was required on computer A.

For this program, what will be the target clock rate for the computer B in GHz unit?

EA = 10s,EB = 6s

EA/EB = 10/6 = (NA\*TA)/ (1.2NA\*TB)

TB = ½TA,

So, 2FA = FB

Clock rate for computer B is 8GHz

4.

HW3

TLB -> Cache

TLB -> (page table in main memory) -> (disk, by Operating System) -> (main ­­­­memory) -> (page table) -> (TLB) -> Cache -> (main memory)

7.

a)

No TLB miss and no Cache miss

* The data is gotten from the TLB itself

1,000,000 \* 1ns for TLB access,

1,000,000 \* 1ns for cache access

Total 2,000,000 ns = **0.002 s**

No TLB miss and Cache miss

* The data is gotten from cache, but it needs to access to main memory (to get the right block)

1,000,000ns for TLB

Cache miss = 1,000,000 instructions \* Miss rate10% \* Penalty

= 1,000,000 \* 0.1 \* 150us = **15s**

TLB miss, no page fault

* The data is not in the TLB, but in the Page

1,000,000 \* 0.25 \* 20us = **5s**

TLB miss, page fault

Among TLB miss, 0.01% is page fault

Fraction for TLB miss is 1,000,000 \* 0.25

Fraction for page fault is 1,000,000 \* 0.25 \* 0.0001

Such that 1,000,000 \* 0.25 \* 0.0001 \* 1ns (page service) = **25s.**

So, the total time is **45.002 second**

If page fault, the information is not in main memory, then it is also not in cache.

b)

page size is 4K, 4K = 22 \* 210 = 212, so the page index bit is 12.

So, the rest of 20bits among 32bits are page number.

Therefore, 0x4CD67 is page number

And that page number is mapped to 0x28701

And the block offset is stays same

So 0x28701821 is the physical address.

In binary, it will be

0010 1000 0111 0000 0001 1000 0010 0001

Since the system uses same cache as in #6,

TAG is 11 bits

Cache line index is 11bits

Block index is 10 bits

TAG = 001 0100 0011 = 0x143

Cache index = 100 0000 0110 = 0x406

Block index = 00 0010 0001 = 0x021