CMPT 300: Assignment 4 – Part 1

Name: Sungwi Kim

Student number: 301592065

Part1. Virtual memory question

(1)

Calculation Process

given that the page size is 4096 bytes, which is 2^{12} bytes,

- the number of virtual memory is 2^{20} pages (= 2^{32} / 2^{12})
- the number of physical memory is 2^{6} pages (= 2^{18}/ 2^{12})

virtual address we look for is 0x11123456, which can be converted to

0b 0001 0001 0001 0010 0011 0100 0101 0110

The bottom 12 bits represent offset since the page size is 2^{12}.

The first 20 bits represent the page number, which is supposed to point to a certain physical page, C.

Finally, the physical address we look for is computed as C + offset.

Software Operation

- when OS is provided with a physical address, OS will load the memory from the disk into physical memory if the provided address does not exist in physical memory.
- OS holds a page table that maps the virtual page to the physical page.

Hardware Operation

- Calculation from virtual memory to physical memory using page table is processed by the memory management unit.
- Takes the page and offset from given virual address, and find the corresponding physical page using the page table. Then, sum up the physical page and offset to generate the physical address.

(2)

effective access time

= (1-p) * memory-access time + p * page-fault service time

- look for access time of no more than 200ns
- memory-access time = 100 ns
- page-fault service time
    - if an empty page is available or a replaced page is not modified
        - 8ms = 8,000,000ns
        - takes 30% of the time
    - if a replaced page is modified
        - 20ms = 20,000,000ns
        - takes 70% of the time

Thus,

page-fault service time = 8,000,000*0.3 + 20,000,000*0.7

= 16400000 ns

Using values above,

200 = (1-p)(100) + p(16400000)

➔ p = 100 / 16399900 ≈ 6.0976 * 10^{-6}

Therefore, the maximum acceptable page-fault rate is **6.0976 * 10^{-6}**