ID1206: Review Questions 3

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1 Question 1

Name two differences between logical and physical addresses.

1.1 Answer

A physical address refers to a location in a memory unit and is generated by the memory management unit(MMU) and is mostly not accessible for the user. A logical address on the other hand is an abstract or virtual address generated by the CPU and is mapped to physical addresses. The user has access physical addresses through logical addresses.

2 Question 2

Consider a logical address space of 64 pages of 1024 words each, mapped onto a physical memory of 32 frames.

a. How many bits are there in the logical address?

b. How many bits are there in the physical address?

2.1 Answer

a. We have $1024 = 2^{10}$ words per page and $64 = 2^6$ pages which is $2^{10} * 2^6$ words in total. We would then need $10 + 6 = 16$ bits to represent every logical address.

b. We have $32 = 2^5$ frames and frame/page size of $1024 = 2^{10}$, thus we need $5 + 10 = 15$ bits to represent the physical addresses.

3 Question 3

Assuming a 1-KB page size, what are the page numbers and offsets for the following address references (provided as decimal numbers).

a. 3085

b. 42095

c. 215201

d. 650000

e. 200000

3.1 Answer

To calculate the page number and offset for the addresses we start with converting the address to binary format. The address 3085_{10} can be done manually by constantly dividing by 2 and take note of the remainder. The address in binary is 110000001101_2. We will zero extend this number since we assume a 32-bit system. Now we split this number into two parts for page number and offset. Since the page size is $1024 = 2^{10}$ we have a 10 bit offset. The $32 - 10 = 22$ number of bits represent the page number. We now convert the individual parts to their respective decimal number. We have $00000000000000000000110000001101_2 \rightarrow 0000000000000000000011_2$ and 0000001101_2 respectively for the page number and offset. Converting these back to binary gives us the page number 3 with offset of 13. The process is applied to every reference and the result is presented below.

Address	**Page number**	**Offset**
3085	3	13
42095	41	111
215201	210	161
650000	634	784
200000	195	320

4 Question 4

Consider a logical address space of 256 pages with a 4-KB page size, mapped onto a physical memory of 64 frames.

a. How many bits are required in the logical address?

b. How many bits are required in the physical address?

4.1 Answer

a. The logical address space is $2^m = number\ of\ pages\ *\ page\ size = 256 * 4096 = 1048576$ where $m = number\ of\ bits\ required$. Thus we have $m = \log_2 1048576 = 20$.

b. The physical address space is $2^n = number\ of\ frames * frame/page\ size = 64 * 4096 = 262144$. The amount of bits required for the physical addresses is therefore $n = \log_2 262144 = 18$.

5 Question 5

Under what circumstances do page faults occur? Describe the actions taken by the operating system when a page fault occurs.

5.1 Answer

A page fault occurs when a program tries to access a page that does not yet exist in physical memory (main memory). When a page fault occurs, the operating system will first determine if the memory access is valid or not. If it is invalid, the process/program will be terminated. If it is valid, a free frame will be located and the requested page will be loaded into this newly allocated frame. Lastly, the process internal table and the page table is updated and the instruction is restarted.