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Part 3: HW 3

Virtual Memory

BB Due Date: Wednesday, April 20th Midnight

1) List one benefit of using direct mapping, and one benefit of fully associative mapping.

Direct Mapping: Because there is only one possible location to store each address, it takes almost no time to search for a hit.

Associative Mapping: Has a higher hit ratio because addresses can be cached in multiple locations within a set.

2)

a) List 3 reasons for using a virtual address space.

1. Allows for more addresses than can be stored in RAM
2. Simplifies programming because it gives each program a dedicated address space
3. Increases security because programs are not able to read/write each other's addresses

b) What is the difference between a virtual address and a physical address?

A virtual address is an address in virtual memory that may or may not be mapped to a physical address. A physical address identifies a single location in RAM.

3) When do we replace a page in memory?

Pages are replaced when a page fault occurs and a new page must be stored in memory. Which page that gets replaced is determined by an algorithm in the operating system.

4) What is the TLB, and why is it used?

The Translation Lookaside Buffer is a cache of virtual address translations that prevents the MMU from always having to slowly access RAM to read the page table and translate addresses.

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5)

a) If the page size is 2048 bytes and the virtual addresses have a size of 18 bits. How many entries does the page table have?

2^18/2^11=2^7= 128

b) If the maximum number of frames that can fit into the RAM is 32, what is the format of physical address? (number of bits for page number and offset).

32=2^5
2^18/2^5=2^13

page number = 13 bits
offset = 5 bits

6) Consider this page table for a program that is running by CPU.

Page table

Frame	Valid bit
11	1
-	0
01	1
00	1
-	0
-	0
10	1
-	0

Answer the following questions:

a) What is the page size? **Assume the virtual addresses have a length of 10 binary bits, and the page table is complete (i.e. all virtual pages have entries in the page table).**

2^10/2^3=2^7
page size = 2^7 = 128 bytes

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b) Does a page fault occur when a program requires data present in the virtual address 781_{10}? If not, what is the corresponding physical address?

781 = 1100001101
110 = 6
No page fault
Physical Address: 100001101 = 269 base 10

c) Does a page fault occur when a program requires data present in the virtual address 291_{10}? If not, what is the corresponding physical address?

291 = 0100100011
010 = 2
No page fault
Physical address: 010100011 = 163 base 10