

Directions: Complete the following questions as best you can. You're encouraged to discuss these questions with the people around you. This quiz IS NOT GRADED. Its only intended to help you understand the material.

1. A brand new computer system, the STEEV2000™, has just been released to fanfare around the globe! This machine is unique in that it has a 36-bit virtual address space. It translates these addresses using paging, with a page size of 8 kilobytes. There are 4 bytes per page table entry. Each entry contains 4 bits of protection and use information; the rest is used for addressing.

a) How many pages are in the virtual address space?

The address space is 36 bits. Each page is 8kbytes, which will require 13 bits to address each byte. This means that there are $36 - 13 = 23$ bits corresponding to the page number, which means there will be 2^{23} pages. (8,388,608 pages!)

b) What is the maximum size of addressable physical memory on this system?

This question is slightly tricky!

There are 4 bytes of page table entry, which is 32 bits of addressing. 4 of these bits are used for other purposes, leaving us with 28 bits of address. This means that each page table entry can point to any one of 2^{28} pages. Because each page is 8kbytes, which takes 13 bits to address, a full physical address for this system is $28 + 13 = 41$ bits. This means that can address 2^{41} bits of physical memory on this system. (2,199,023,255,552 bytes!)

c) Suppose the currently running process makes a call to load data from 36-bit virtual address 0x12345BEEF. Draw a picture of how this address is translated using paging and show how the actual data is found in physical memory.

0x12345BEEF = 0001 0010 0011 0100 0101 1011 1110 1110 1111

*The last 13 bits of this address is the **offset**. The first 23 bits is used to lookup into the page table. In the page table, there is a **page address**, which is 28 bits. This page address + offset = the final physical address.*

Look at my section notes or the lecture notes for a rough visual picture of this process.

2. Briefly explain the difference between the user mode and privileged mode of a CPU. Why is this difference important for the overall goals of an operating system?

In user mode, there are certain things that are not allowed. This includes accessing certain registers and areas of memory. This is for the goal of providing protection.

These restrictions are used by the OS to maintain control over the hardware and protect itself from accidental or deliberate interference from user programs.

Note: this question came from the U of Waterloo.

3. What is the difference between an Interrupt and a System Call?

An interrupt is triggered asynchronously by hardware. A system call is a type of exception, and is triggered by a special machine instruction executed by a user process.