CS5250 Advanced Operating Systems

Pop Quiz 2

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Concept checks. Below is a series of short questions on today's lecture. The aim of which is to help you checkpoint on your understanding of the lecture. Please do not copy from others but rather try to summarize your understanding – only that way will you know if you understood it. Try to answer each as briefly as you can while explaining the full concept. Please do not cut and paste from the lecture or the Internet. Rather, summarize your understanding. The actual marks derived from the many pop quizzes you will get is minuscular. But its importance as a knowledge checkpoint is not.

1. What is a x86 general purpose register vs a control register?
   - IA32 has eight 32-bit general purpose registers, intel64 has sixteen 64-bit registers
   - The general-purpose registers are usually used for arithmetic, transfer value and temporarily store value
   - X86 has several control registers which is CR0, CR1, CR2, CR3, CR4
   - The control registers are designed for various purposes for example when dealing with the issues related to virtual memory
2. What is a x86 segment vs a page?
   - A segment is a continuous block in linear address Space, page is a block of virtual memory with fixed size.
   - When mapping the logical address to linear address, we need the segment selector to find the segment descriptor to get the segment base address, then combined with the offset to find a linear address in segment. This process is called segmentation.
   - If we used page when mapping the linear address to physical address, we need to execute a process get the page directory, get the page table, finally get a physical address in physical address in physical address space. This process is called paging.
3. What is the x86 operating mode vs memory model?
   - The IA32 of x86 supports the following operating mode:
     - Real-address Mode
     - Protected Mode
     - System Management Mode
     - Virtual-8086 Mode (rarely used)
   - The Intel64 of x86 proposed a new mode: Intel 64 IA-32e Mode which has 2 sub-modes: compatibility mode and 64-bit mode
   - X86 has 3 memory addressing model:
     - Flat Model
     - Segmented Model
     - Real-Address Mode Model

- The relationship between operating mode and memory model:
  - Protected Mode can use any three of the memory models
  - Real-address Mode can only use Real-Address Mode Model
  - System Management Mode use memory model which is similar to the Real-Address Mode Model
4. What are protection rings?
   - The protection rings of x86 are designed for isolation and security
   - It introduces the concept of privilege levels (0 to 4), Ring 0 is the highest level, Ring 3 is the lowest level. Kernel code runs in Ring 0, user code runs in ring 3.
   - The protection rings restrict what code can do and cannot do.
   - There is a 2-bits CPL field in Code segment register, which specify the current privilege level (CPL)
5. What is the relationship between segments, segment descriptors and segment descriptor tables?
   - Segment is continuous linear address.
   - Segment descriptors is stored in segment descriptor tables.
   - We use segment descriptor to find segment.
6. Suppose the CS register now contains the value "0xabc", and the IP register contains the value "0x23". What is the value of the program counter, i.e., CS:IP, in the x86 real-address mode?
   - Solution:

   CS = 0xabc

   IP = 0x23

   Real address = CS*16 + IP = 0xabc0 + 0x23 = 0xabe3