

A Dialogue on Memory Virtualization

Student: So, are we done with virtualization?

Professor: No!

Student: Hey, no reason to get so excited; I was just asking a question. Students are supposed to do that, right?

Professor: Well, professors do always say that, but really they mean this: ask questions, *if they are good questions*, and you have actually put a little thought into them.

使某人泄气, 使某人不坚定

Student: Well, that sure takes the wind out of my sails.

Professor: Mission accomplished. In any case, we are not nearly done with virtualization! Rather, you have just seen how to virtualize the CPU, but really there is a big monster waiting in the closet: memory. Virtualizing memory is complicated and requires us to understand many more intricate details about how the hardware and OS interact.

内存的虚拟化

Student: That sounds cool. Why is it so hard?

Professor: Well, there are a lot of details, and you have to keep them straight in your head to really develop a mental model of what is going on. We'll start simple, with very basic techniques like base/bounds, and slowly add complexity to tackle new challenges, including fun topics like TLBs and multi-level page tables. Eventually, we'll be able to describe the workings of a fully-functional modern virtual memory manager.

写作思路: 由简入难

Student: Neat! Any tips for the poor student, inundated with all of this information and generally sleep-deprived?

Professor: For the sleep deprivation, that's easy: sleep more (and party less). For understanding virtual memory, start with this: every address generated by a user program is a virtual address. The OS is just providing an illusion to each process, specifically that it has its own large and private memory; with some hardware help, the OS will turn these pretend virtual addresses into real physical addresses, and thus be able to locate the desired information.

topic 1

topic 2

Student: OK, I think I can remember that... (to self) every address from a user program is virtual, every address from a user program is virtual, every ...

Professor: What are you mumbling about?

Student: Oh nothing.... (awkward pause) ... Anyway, why does the OS want to provide this illusion again?

Professor: Mostly *ease of use*: the OS will give each program the view that it has a large contiguous **address space** to put its code and data into; thus, as a programmer, you never have to worry about things like “where should I store this variable?” because the virtual address space of the program is large and has lots of room for that sort of thing. Life, for a programmer, becomes much more tricky if you have to worry about fitting all of your code data into a small, crowded memory.

Student: Why else? *topic 3*

Professor: Well, isolation and protection are big deals, too. We don’t want one errant program to be able to read, or worse, overwrite, some other program’s memory, do we?

Student: Probably not. Unless it’s a program written by someone you don’t like.

Professor: Hmmm.... I think we might need to add a class on morals and ethics to your schedule for next semester. Perhaps OS class isn’t getting the right message across.

Student: Maybe we should. But remember, it’s not me who taught us that the proper OS response to errant process behavior is to kill the offending process!