

Slide 1

Administrivia

- Reminder: Homework 1 due today (written part by 5pm, programming part by 11:59pm). Hardcopy preferred for written part, but okay to submit by e-mail if you must!
- Reminder: Quiz 1 Wednesday. Short question(s) based on chapter 1, lectures. "Open book/notes", meaning access to textbook, your notes, anything on course Web site.

Slide 2

Minute Essay From Last Lecture

- As suspected, several students did not have or had not looked at the textbook.
- Those who had done (some) reading mentioned history, overview, o/s are more complicated than thought, interrupts, kernel versus supervisor, "ontogeny recapitulates phylogeny", figure with "monsters" (??), author must be an "interesting chap" with a sense of humor.

Operating System Structures

Slide 3

- Clearly o/s could involve a whole lot of code (tens of millions of lines of code, if one can believe Wikipedia). How to structure?
- Choices include:
 - Monolithic systems.
 - Layered systems.
 - Microkernels.
 - Client-server model.
 - Virtual machines.
 - Exokernels.

Monolithic Systems

Slide 4

- Tanenbaum's description in the previous edition of the textbook — "The Big Mess". Maybe an exaggeration, since there can be *some* structure.
- Examples include MS-DOS, early UNIX.
- Arguments for/against?

Slide 5

Monolithic Systems, Continued

- Arguments for this approach — “works, sort of”?
- Arguments against — easier for one malfunctioning component to crash others.

Slide 6

Layered Systems

- Idea — use layers of abstraction, just as one structures application programs.
- Examples include THE, MULTICS, OS/2, Windows NT (more so in early releases).
- Arguments for/against?

Layered Systems, Continued

- Arguments for — it's an extra layer of abstraction.
- Arguments against — it's an extra layer of abstraction.
- (Or in other words — nice separation of concerns, modularity, but tricky to plan layers, performance can be slow.)

Slide 7

Microkernel Systems

- Idea — make kernel itself as small as possible, package other services separately, as independent processes.
- Examples include MINIX (written by Tanenbaum).
- Arguments for/against?

Slide 8

Microkernel Systems, Continued

- Arguments for — modularity, reliability.
- Arguments against — tricky to plan layers, performance might be reduced.

Slide 9

Virtual Machines

- Idea — o/s provides a simulation of the actual physical machine, this “virtual machine” then runs another o/s – or several of them.
- Examples include VM/370, Windows support for old MS-DOS programs, VMware, Java Virtual Machine, other virtualization schemes.
- (Notice how this is an idea that fell out of favor for a while, then came back.)
- Arguments for/against?

Slide 10

Slide 11

Virtual Machines, Continued

- Arguments for — separates multiprogramming from other concerns, emulation aspect can be useful, useful in o/s development.
- Arguments against — another layer, so can be slower. Also, may not be possible for some hardware — e.g., if privileged instructions executed in user mode are simply ignored.

Slide 12

VM/370

- Idea — provide multiple “virtual machines”, each running its own o/s, which could be:
 - “Real” o/s such as MVS (another mainframe o/s) — in turn running many processes.
 - Not-quite-real o/s CMS — interactive single-user system rather like MS-DOS, runs under VM/370 only (not on real hardware).
- Allows sharing of physical resources among multiple “client” o/s's:
 - CPU sharing — similar to multitasking.
 - I/O device sharing — share physical devices, or allow exclusive use.

VM/370, Continued

Slide 13

- How does this work? briefly:
 - Client o/s's run native code, request o/s services in the usual way (interrupt or system call).
 - Interrupt handler is part of VM/370 — so it processes I/O requests/interrupts, errors, etc.
 - Client o/s system code runs in simulated supervisor mode (really user mode).
- Successors to VM/370 (VM/ESA, z/VM) currently being used to run many copies of Linux on a mainframe (!).
- More about virtualization in chapter 8 of textbook.

Minute Essay

Slide 14

- What is/was most difficult about doing Homework 1? What was most interesting?