Introduction to Operating Systems

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How This Course Fits in the UW CSE Curriculum

• CSE 333: Systems Programming
  — Project experience in C/C++
  — How to use the operating system interface
• CSE 451: Operating Systems
  — How to make a single computer work reliably
  — How an operating system works internally
• CSE 452: Distributed Systems (spring 2013)
  — How to make a set of computers work reliably, despite failures of some nodes

Project: Pintos

• Build an operating system
  — That can boot on PC hardware
  — Run a web server (and other apps)
• We give you some basic building blocks
  — Four assignments, that build on each other
    • Threads, user programs, virtual memory, networking
  — Work in groups of 2-3
• First assignment due two weeks from Thursday

Problem Sets

• Four assignments spread over quarter
  — Practice for exams
  — Done individually
• First assignment, due a week from Thursday
  — Build a shell, with pipes: ls | wc
  — Should be review from 333
  — See Chapter 3.1-3.4 for a review
  — Posted online
Main Points (for today)

- Operating system definition
  - Software to manage a computer’s resources for its users and applications
- OS challenges
  - Reliability, security, responsiveness, portability, ...
- OS history
  - How are OS X, Windows 7, and Linux related?

What is an operating system?

- Software to manage a computer’s resources for its users and applications

Operating System Roles

- Referee:
  - Resource allocation among users, applications
  - Isolation of different users, applications from each other
  - Communication between users, applications
- Illusionist
  - Each application appears to have the entire machine to itself
  - Infinite number of processors, (near) infinite amount of memory, reliable storage, reliable network transport
- Glue
  - Libraries, user interface widgets, ...

Thought Question

- What do you need from hardware to be able to:
  - Isolate different applications from each other?
  - Isolate different users from accessing each others files?
Example: web service

• How does the server manage many simultaneous client requests?
• How do we keep the client safe from spyware embedded in scripts on a web site?
• How do we keep updates to the web site consistent?

OS Challenges

• Reliability
  – Does the system do what it was designed to do?
• Availability
  – What portion of the time is the system working?
  – Mean Time To Failure (MTTF), Mean Time to Repair
• Security
  – Can the system be compromised by an attacker?
  – Privacy
    • Data is accessible only to authorized users
• Both require very careful design and code
Early Operating Systems: Computers Very Expensive

- One application at a time
  - Had complete control of hardware
  - OS was runtime library
  - Users would stand in line to use the computer
- Batch systems
  - Keep CPU busy by having a queue of jobs
  - OS would load next job while current one runs
  - Users would submit jobs, and wait, and wait, and

Time-Sharing Operating Systems: Computers and People Expensive

- Multiple users on computer at same time
  - Multiprogramming: run multiple programs at same time
  - Interactive performance: try to complete everyone’s tasks quickly
  - As computers became cheaper, more important to optimize for user time, not computer time
Today’s Operating Systems: Computers Cheap

- Smartphones
- Embedded systems
- Web servers
- Laptops
- Tablets
- Virtual machines
- ... 

Tomorrow’s Operating Systems

- Giant-scale data centers
- Increasing numbers of processors per computer
- Increasing numbers of computers per user
- Very large scale storage

Bonus Thought Question

- How should an operating system allocate processing time between competing uses?
  - Give the CPU to the first to arrive?
  - To the one that needs the least resources to complete? To the one that needs the most resources?
  - What if you need to allocate memory?
  - Disk?

Textbook

- Lazowska, Spring 2012: “The text is quite sophisticated. You won’t get it all on the first pass. The right approach is to [read each chapter before class and] re-read each chapter once we’ve covered the corresponding material… more of it will make sense then. Don’t save this re-reading until right before the mid-term or final – keep up.”