CSE 120
Principles of Operating Systems
Fall 2015
Lecture 1: Course Introduction
Geoffrey M. Voelker
Lecture 1 Overview

- Class overview, administrative info
- What is an operating system?
Personnel

- Instructor
  - Geoff Voelker
    - Office hours: Mon 3-4pm & Wed 4-5pm in CSE 3108

- TAs
  - Daniel Knapp
  - Zach Meyer
  - Manindra Moharana
  - Derrick Smith

- Discussion
  - Wed @ 7pm in Center 119
  - Fri @ 8am, Pepper Canyon 109
  - No discussion first week
CSE 120 Class Overview

- Course material taught through class lectures, textbook readings, and handouts
- Course assignments are
  - Homework questions (primarily from the book)
  - Three large programming projects in groups
- Discussion sections are a forum for asking questions
  - Lecture material and homework
- Other forums
  - Discussion board (http://piazza.com)
- This Fall we have two sections of CSE 120
  - Very similar, close coordination on the projects
Homeworks

- There will be 4-5 homeworks throughout the quarter
  - Reinforce lecture material…no better practice

- Collaboration vs. cheating
  - I encourage you to discuss homework problems with others
    » You can learn a lot from each other
  - But there is a distinction between collaboration and cheating
  - Rule of thumb: Discuss together in library, walk home, and write up answers independently
  - Cheating is copying from other student’s homeworks or solution sets, searching for answers on the Web, etc.
  - Suspicious homeworks will be flagged for review
Textbook

"This is the planet where nachos rule."
Nachos

- Nachos is an instructional operating system
  - It is a user-level operating system and a machine simulator
    - Not unlike the Java runtime environment
    - Will become abundantly clear (or not so clear) very soon
  - Programming environment will be Java on Unix (Linux)
  - The projects will require serious time commitments
    - Waiting until the last minute is not a viable option

- You will do three+ projects using Nachos
  - Concurrency and synchronization
  - System calls, processes, multiprogramming
  - Virtual memory

- You will work in groups of 1-2 on the projects
  - Start thinking about partners
Labs

- We will use the labs in the CSE basement
  - Linux running on x86 machines
- You may also use your home machine
  - The same project source will work on Windows (mostly)
  - Note: We will test and grade on uAPE machines
  - Be sure to test your projects there as well

- Why work in the labs?
  - TAs there to help
  - Classmates there to help (and have fun)
  - I will visit the labs to help
Exams

- **Midterm**
  - Tuesday October 27\textsuperscript{nd} (put in calendar)
  - Covers first half of class

- **Final**
  - Tuesday December 8\textsuperscript{th} (put in calendar)
  - Covers second half of class + selected material from first part
    » I will be explicit about the material covered

- **No makeup exams**
  - Unless absolute dire circumstances

- **Crib sheet**
  - You can bring one double-sided 8.5x11" page of notes to each exam to assist you in answering the questions
  - Not a substitute for thinking
Grading

- Homeworks: 15%
  - Think of these collectively as a take-home midterm
- Midterm: 25%
- Final: 30%
- Projects: 30%
  - Breakdown: 1.5%, 7.5%, 9%, 12%
How *Not* To Pass CSE 120

- Do not come to lecture
  - Lecture is far too early, the slides are online, and the material is in the book anyway
  - Lecture material is the basis for exams and directly relates to the projects

- Do not do the homework
  - It’s only 15% of the grade
  - Excellent practice for the exams, and some homework problems are exercises for helping with the project
  - 15% is actually a significant fraction of your grade (could be difference between at least one letter grade)
How *Not* To Pass (2)

- Do not ask questions in lecture, office hours, or online
  - It’s scary, I don’t want to embarrass myself
  - Asking questions is the best way to clarify lecture material at the time it is being presented
  - Office hours and email will help with homeworks, projects

- Wait until the last couple of days to start a project
  - We’ll have to do the crunch anyways, why do it early?
  - The projects cannot be done in the last few days
  - Repeat: The projects cannot be done in the last few days
  - Each quarter groups learn that starting early meant finishing all of the projects on time…and some do not
  - (p.s. The projects cannot be done in the last few days)
Class Web Page

http://www.cse.ucsd.edu/classes/fa15/cse120-a/

- Serves many roles…
  - Course syllabus and schedule (updated over quarter)
    - Lecture slides
  - Homework handouts
  - Project handouts

- Supplemental readings on Unix, monitors, and threads
  - e.g., seminal research paper describing the early Unix system
  - FYI only, but you might find it interesting
  - Concepts in paper might seem obvious and familiar, but they were new at one time
Questions

- Before we start the material, any questions about the class structure, contents, etc.? 
Why Operating Systems?

- Why are we making you sit here today, having to suffer through a core course in operating systems?
  - It’s not like everyone will become OS developers, after all

- Understand what you use
  - Understanding how an OS works helps you develop apps
  - System functionality, performance, efficiency, etc.

- Pervasive abstractions
  - Concurrency: Threads and synchronization are common modern programming abstractions (Java, .NET, etc.)

- Complex software systems
  - Many of you will go on to work on large software projects
  - OSes serve as examples of an evolution of complex systems
This course addresses classic OS concepts
- Services provided by the OS
- OS implementation on modern hardware
- Co-evolution of hardware and software
- Techniques for implementing software systems that are
  » Large and complex
  » Long-lived and evolving
  » Concurrent
  » Performance-critical

System software tends to be mysterious
- Virtual memory? Wazzat?

Our goal is to reveal all mysteries
The `top` command output shows the system's status:

- **System Uptime**: The system has been running for 275 days.
- **Tasks**: 171 total, 1 running, 0 waiting, 0 stopped, 0 zombie.
- **CPU Usage**: 0.1% user, 0.1% system, 0.0% idle, 0.0% iowait, 0.0% IRQ, 0.0% softIRQ, 0.0% steal.
- **Memory Usage**: 16467276k total, 1415969k used, 3307534k free, 171168k buffers, 884340k cached.

The table below provides details on the processes running on the system:

<table>
<thead>
<tr>
<th>PID</th>
<th>USER</th>
<th>PR</th>
<th>NI</th>
<th>VIRT</th>
<th>RES</th>
<th>SHR</th>
<th>S</th>
<th>%CPU</th>
<th>TIME+</th>
<th>COMMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>14677</td>
<td>voelker</td>
<td>20</td>
<td>0</td>
<td>55548</td>
<td>3232</td>
<td>2364</td>
<td>R</td>
<td>0.00</td>
<td>0.07</td>
<td>top</td>
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<tr>
<td>24637</td>
<td>voelker</td>
<td>20</td>
<td>0</td>
<td>86300</td>
<td>6364</td>
<td>1024</td>
<td>S</td>
<td>32:06:70</td>
<td>kthreadd, mosh-server, init</td>
<td></td>
</tr>
<tr>
<td>1 root</td>
<td>20</td>
<td>0</td>
<td>57812</td>
<td>1636</td>
<td>584</td>
<td>S</td>
<td>0.00</td>
<td>1:26:73</td>
<td>watchdog/0, migration/0</td>
<td></td>
</tr>
<tr>
<td>2 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.03:13</td>
<td>watchdog/2, migration/2, migration/3</td>
<td></td>
</tr>
<tr>
<td>3 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.04:38</td>
<td>watchdog/3, migration/3, migration/3</td>
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</tr>
<tr>
<td>4 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>9:54:94</td>
<td>ksoftirqd/0, ksoftirqd/1, ksoftirqd/1</td>
<td></td>
</tr>
<tr>
<td>5 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.00:01</td>
<td>watchdog/1</td>
<td></td>
</tr>
<tr>
<td>6 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.04:39</td>
<td>watchdog/2, migration/2, migration/3</td>
<td></td>
</tr>
<tr>
<td>7 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>9:44:37</td>
<td>ksoftirqd/2, migration/3, migration/3</td>
<td></td>
</tr>
<tr>
<td>8 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.00:01</td>
<td>watchdog/1</td>
<td></td>
</tr>
<tr>
<td>9 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.00:01</td>
<td>watchdog/2, migration/3, migration/3</td>
<td></td>
</tr>
<tr>
<td>10 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>9:01:67</td>
<td>ksoftirqd/3, migration/3, migration/3</td>
<td></td>
</tr>
<tr>
<td>11 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>0.00:01</td>
<td>watchdog/3</td>
<td></td>
</tr>
<tr>
<td>12 root</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>S</td>
<td>2:30:99</td>
<td>events/0</td>
<td></td>
</tr>
</tbody>
</table>

The output shows processes with various CPU usage, memory usage, and other resource details.
Fundamental OS Issues

The fundamental issues/questions in this course are:

- **Structure**: how is an operating system organized?
- **Sharing**: how are resources shared among users?
- **Naming**: how are resources named (by users and programs)?
- **Protection**: how are users/programs protected from each other?
- **Security**: how can information access/flow be restricted?
- **Communication**: how to exchange data?
- **Reliability and fault tolerance**: how to mask failures?
- **Extensibility**: how to add new features?
Fundamental OS Issues (2)

- **Concurrency**: how to control parallel activities?
- **Performance**: how to make efficient use of resources, reduce OS overhead?
- **Scale and growth**: how to handle increased demand?
- **Compatibility**: can we ever do anything new?
- **Distribution**: how to coordinate remote operations?
- **Accountability**: how to charge for/restrict use of resources?

- And the **principles** in this course are the design methods, approaches, and solutions to these issues
What is an Operating System?

- How would you answer?
  - (Yes, I know that’s why you’re taking the course…)
  - (Note: There are many answers…)

CSE 120 – Lecture 1 – Course Intro
What is an operating system?

- The operating system is the software layer between user applications and the hardware.

- The OS is “all the code that you didn’t have to write” to implement your application.
The OS and Hardware

- The OS abstracts/controls/mediates access to hardware resources
  - Computation (CPUs)
  - Volatile storage (memory) and persistent storage (disk, etc.)
  - Communication (network, modem, etc.)
  - Input/output devices (keyboard, display, printer, camera, etc.)

- The OS defines a set of logical resources (objects) and a set of well-defined operations on those objects (interfaces)
  - Physical resources (CPU and memory)
  - Logical resources (files, programs, names)
  - Sounds like OO…
The OS and Hardware (2)

- Benefits to applications
  - Simpler (no tweaking device registers)
  - Device independent (all network cards look the same)
  - Portable (across Win95/98/ME/NT/2000/XP/Vista/7/8/10/…)
  - Transportable (same program across different OSes (Java))
The OS and Applications

- The OS defines a logical, well-defined environment…
  - Virtual machine (each program thinks it owns the computer)
- …for users and programs to safely coexist, cooperate, share resources
  - Concurrent execution of multiple programs (timeslicing)
  - Communication among multiple programs (pipes, cut & paste)
  - Shared implementations of common facilities
    - No need to implement the file system more than once
  - Mechanisms and policies to manage/share/protect resources
    - File permissions (mechanism) and groups (policies)
Other Questions to Ponder

- What is part of an OS? What is not?
  - Is the windowing system part of an OS?
  - Is the Web browser part of an OS?
March 30, 2009

CSE 120

Lecture 1

Course Intro
Other Questions to Ponder

- What is part of an OS? What is not?
  - Is the windowing system part of an OS?
  - Is the Web browser part of an OS?

- Popular OSes today are Windows, Linux, and OS X
  - How different/similar do you think these OSes are?
  - How would you go about answering that question?

- OSes change all of the time
  - Consider the series of releases of Windows, Linux, OS X...
  - What are the drivers of OS change?
  - What are the most compelling issues facing OSes today?
How many lines of code in an OS?
- Win7 (2009): 40M
- OS X (2006): 86M
- Linux (2011): 15M
- What is the largest kernel component?

What does this mean (for you)?
- OSes are useful for learning about software complexity
- OS is just one example of many complex software systems
  - Chrome (2015): 17M
  - Apache (2015): 1.7M
  - JDK (2015): 6M
  - Unreal Engine 3: 2M
- If you become a developer, you will face complexity
For next class...

- Browse the course web
  http://www.cse.ucsd.edu/classes/fa15/cse120-a/
- Read Chapters 1 and 2
  - Start exploring Nachos documentation
- Start thinking about partners for project groups
- No discussion this Friday (nothing to discuss)
- Let the fun begin!