Operating Systems
Overview

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Class website:
http://oscourse.github.io
What is an Operating System?
What is an Operating System?

- A bunch of software and data residing somewhere in memory.
  - But it's not just *any* software.
- OS is the *most privileged* software in a computer.
  - *Privileged* means that OS can do special things, like write to disk, talk over the network, control memory and CPU usage, etc.
- OS manages all system resources
  - CPU, Memory, and I/O devices
Why do we need an OS?

Program 1
(Software)

Instruction Set Architecture (ISA)

Hardware

ISA is specified by the chip vendor, such as Intel, AMD, ARM, NVIDIA etc.
Why do we need an OS?

But the program doesn’t know how to access hardware devices for input/output (I/O)

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<tr>
<th>Program 1</th>
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<tr>
<td>(Software)</td>
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<th>Device Driver libraries for I/O</th>
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| Hardware |

A primitive library OS
Why do we need an OS?

But what if two programs need to share the hardware?

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<th>Program 1</th>
<th>Program 2</th>
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<td>Device Drivers for I/O</td>
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<td>Hardware Multiplexing (Sharing)</td>
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Why do we need an OS?

But what if

- two programs don’t trust each other?
- OS doesn’t trust programs?
- hardware doesn’t trust programs?

= A modern OS

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<td>I/O</td>
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<td>Sharing</td>
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But when does the OS “run”? 
But when does the OS “run”?

Four ways to invoke OS code:

(a) System Calls
(b) Exceptions
(c) Interrupts
(d) Kernel Threads
Layers of Software

User Space

OS

Processes

CPU scheduling

Memory Manager

File system

Device Drivers

System Call Interface

Network Stack

HyperCall Interface

Hypervisor

Virtualization Layer
Interfaces in a Computer System

ISA = Instruction Set Architecture
ABI = Application Binary Interface
API = Application Programming Interface
History of OS

• 1950s and 1960s: Early operating systems were simple batch processing systems
  • Users provided their own “OS” as libraries.

• 1960s and 1970s: Multi-programming on mainframes
  • Concurrency, memory protection, Kernel mode, system calls, hardware privilege levels, trap handling
  • Earliest Multics hardware and OS on IBM mainframes
  • Which led to the first UNIX OS which pioneered file systems, shell, pipes, and the C language.

• 1980s: Personal computing era
  • MacOS, IBM PC and its DOS, Windows, and so forth.
  • Unfortunately, many lessons from earlier multi-programming era were forgotten and had to be re-learned (painfully).

• 1980s also saw the fragmentation of UNIX
  • Each big company had its own version (IBM, Apple, HP, SUN, SGI, NCR, AT&T….)
  • LOT of legal wrangling over IP and copyrights

• 1990s: Then came BSD and Linux
  • Open source.
  • Led the way to modern OSes and cloud platforms

• 1990s also saw wider adoption of threads and parallelism

• 2000 and beyond: Mobile device OS and hypervisors
  • Android, iOS
  • VMWare ESX, Xen, Linux/KVM etc.