Introduction

CS 450 – Spring 2019 - Hale

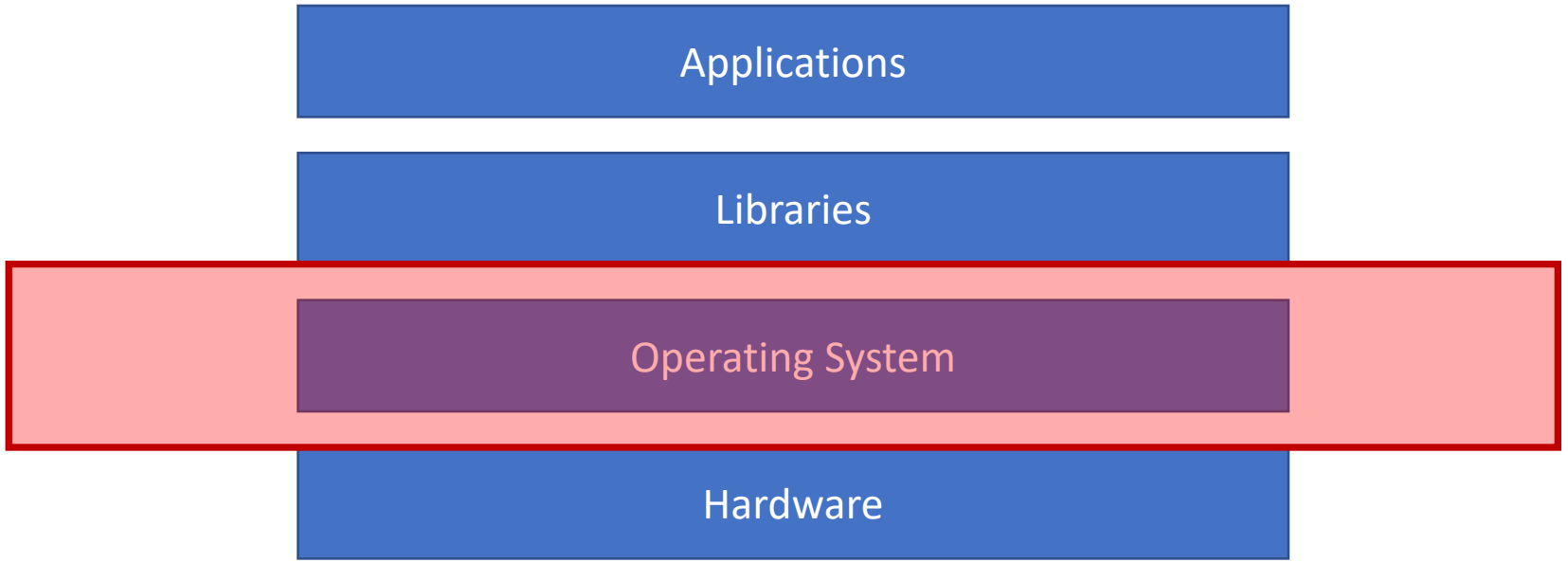
A bit about your instructor

- IIT tells me I have to do this
- I've been doing systems research for about 10 years
  - Computer architecture
  - Virtual machines and high-performance hypervisors
  - Systems security
  - High-performance operating systems (see http://nautilus.halek.co)
  - Parallel computing
- Grew up in Texas. PhD at Northwestern, joined IIT in 2016

What is an Operating System?

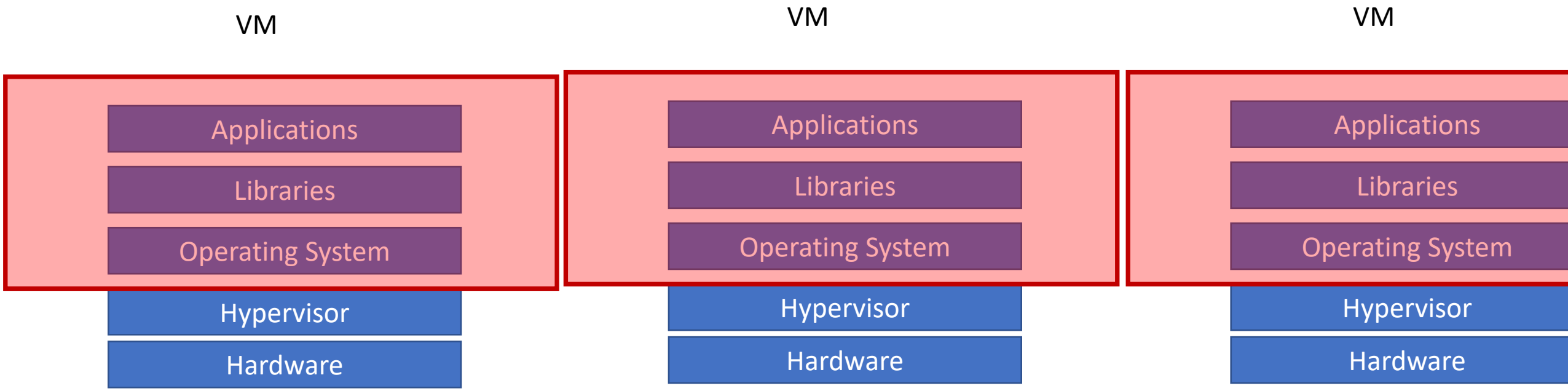
- Not easy to answer!
- Depends on what the needs of the system *are*
- We can try to think about it in terms of its *place* in the HW/SW stack:

Typical HW/SW stack

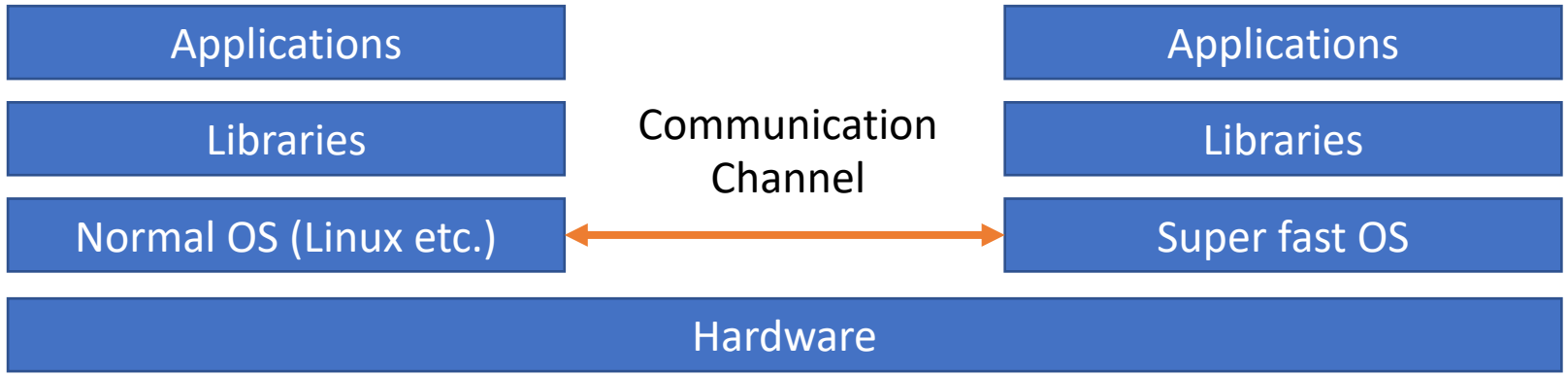


Things are more complicated these days though!

Cloud


VM
VM
VM
Applications
Libraries
Operating System
Applications
Libraries
Operating System
Applications
Libraries
Operating System
Hypervisor
Hardware
Hypervisor
Hardware
Hypervisor
Hardware

Supercomputing



How about the *roles* of an OS?

Library (Abstractions)

- What if you had to write a keyboard driver and a video driver for every program you wrote?
- Abstract away the hardware
- What are the best abstractions? Are they universal?
- (no)

Accountant (Resource Management)

- Allow several programs (and/or users) to use the same machine
- Fairly allocate resources in the system
- Schedule things so they happen in a timely manner

Cop (Security, Isolation, Protection)

- Separate privilege
- Sandbox programs
- Protect programs from one another

OS/kernel distinction

What will we cover?

OS Architecture(s)

- Monolithic
- Microkernel
- Unikernel
- Hybrid
- User vs. kernel

Virtualization

- The illusion of having the whole machine
- Particularly CPU and memory
- Crosscutting topic in systems! (Broadly, resource virtualization)
- (demo)

Concurrency

- OSes must handle events that occur *concurrently*

- Allow things to happen in this manner for *independent* processes
- Allow things to happen in this manner for *interacting* processes
- Subtle distinction between concurrency and parallelism

I/O

- Need to interact with devices
- How?
- MMIO/PIO
- Interrupts
- Drivers, devices, PCI, etc.

File Systems and Persistence

- Disk (device characteristics, scheduling)
- We need data to *stick around*. How do we accomplish that?
- Abstractions (file, directory)
- Interfaces
- Resilience

Advanced Topics

- Networked and Distributed Systems
- Programming Models
- Multicore, SMP, Parallelism
- Virtual Machines
- Containers, Unikernels, Emerging Trends

Overarching Themes

- Taming complexity
- Scaling
- End-to-end principle
- Policy vs. Mechanism
- Secure practices
- Good programming patterns

Why should you care?

- Understanding the machinery (man behind the curtain!)
- Understand performance of programs
- Put things you've learned together
- Understanding and building complex systems is fun! Especially when they work!
- OS dev very rare (and sought after) skillset

Logistics

- Office hours
- Homeworks
- Reading
- Projects (user vs. kernel)
- Exams

Things to do now

- Take a look at the course webpage
- Make sure you've signed up for Piazza
- Do the assigned reading
- Start on project 1a when I post it tonight

Summary

- We will be covering *a lot* of ground
- You will be doing *a lot* of programming (this is the only way to get better at it!)
- This course will be challenging! But you will rise to the challenge