Operating Systems (INFR10079)

2020/2021 Semester 2

Introduction
(Operating Systems and Hardware)

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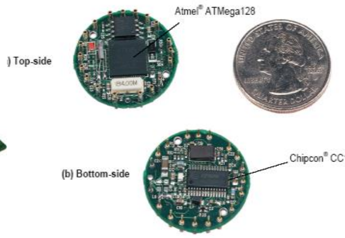
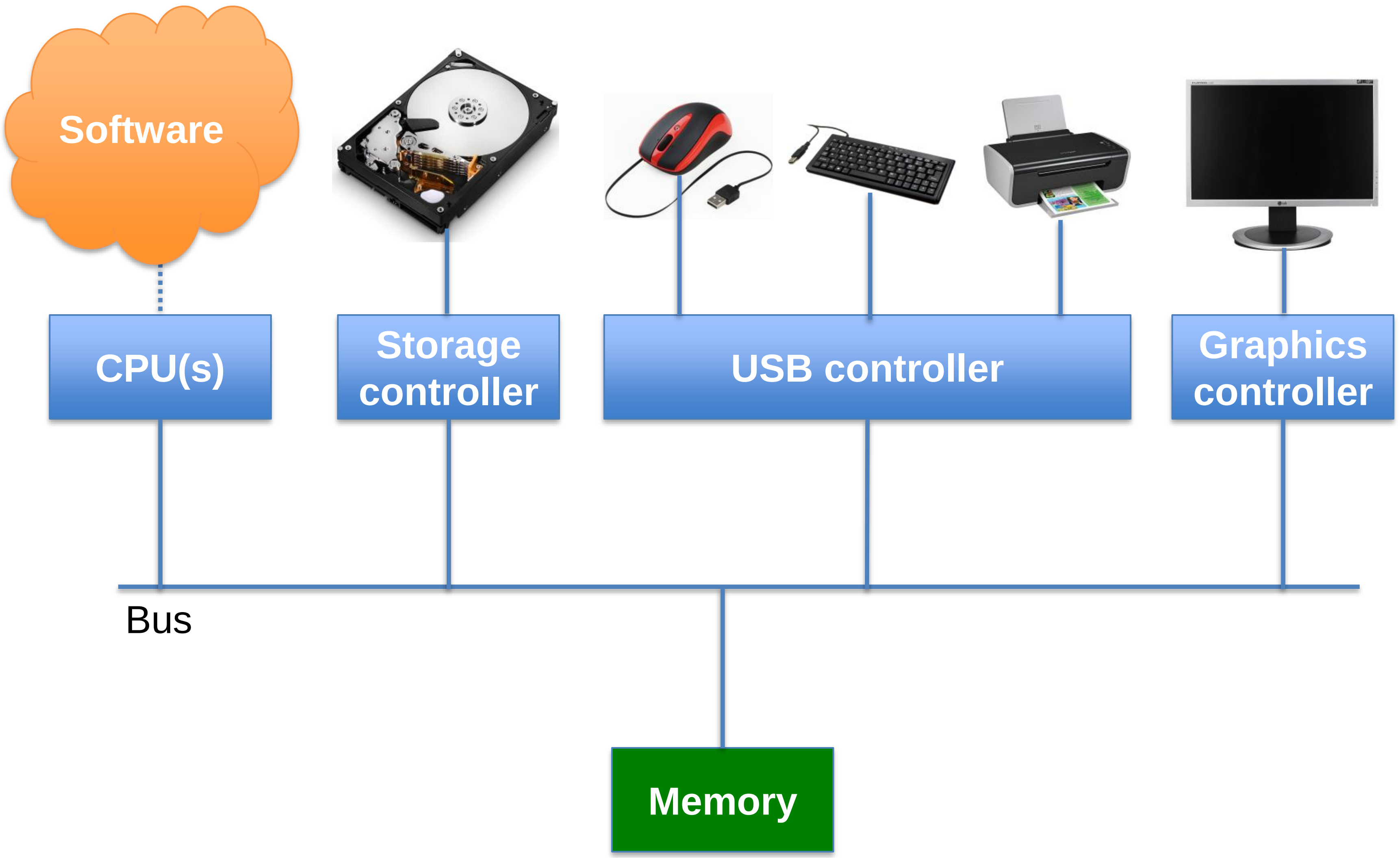
Chapter 1.1, 1.2, 1.3.1, 1.3.2, 1.4.2

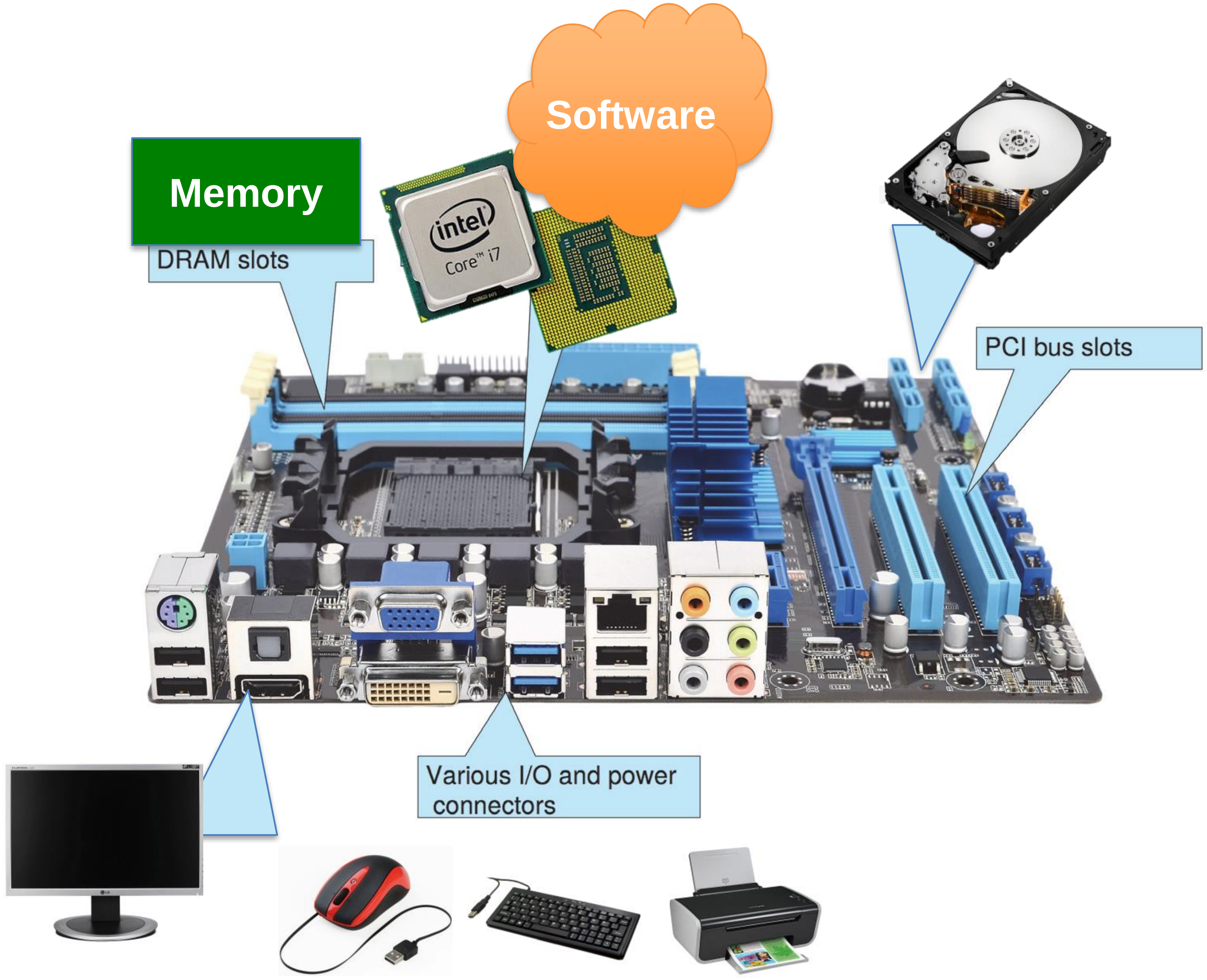
Computing Systems are Everywhere



Modern Computer System



Modern Computer System – PC Motherboard



What is an Operating System?

- A program that manages a computer's hardware

- A program that acts as an intermediary between the user of a computer and computer hardware

- A big program
  - "The **Linux Kernel** Enters 2020 At **27.8 Million Lines** In Git But With Less Developers For 2019", 1 January 2020 at 09:14 AM EST
  - https://www.phoronix.com/scan.php?page=news_item&px=Linux-Git-Stats-EOY2019

Operating Systems

MS-DOS

solaris

iOS

Mac OS X

Windows

hp UX

Plan 9 from Bell Labs

MINIX 3

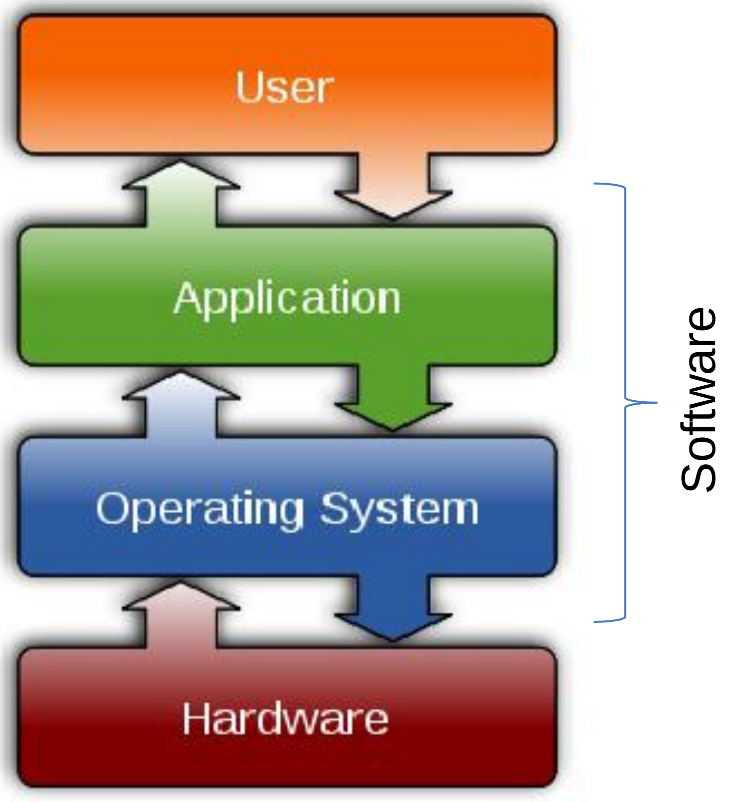
Linux

Some Goals of Operating Systems

- Simplify the execution of user programs and make solving user problems easier
- Use computer hardware efficiently
  - Allow sharing of hardware and software resources
- Make application software portable and versatile
- Provide isolation, security and protection among user programs
- Improve overall system reliability
  - error confinement, fault tolerance, reconfiguration

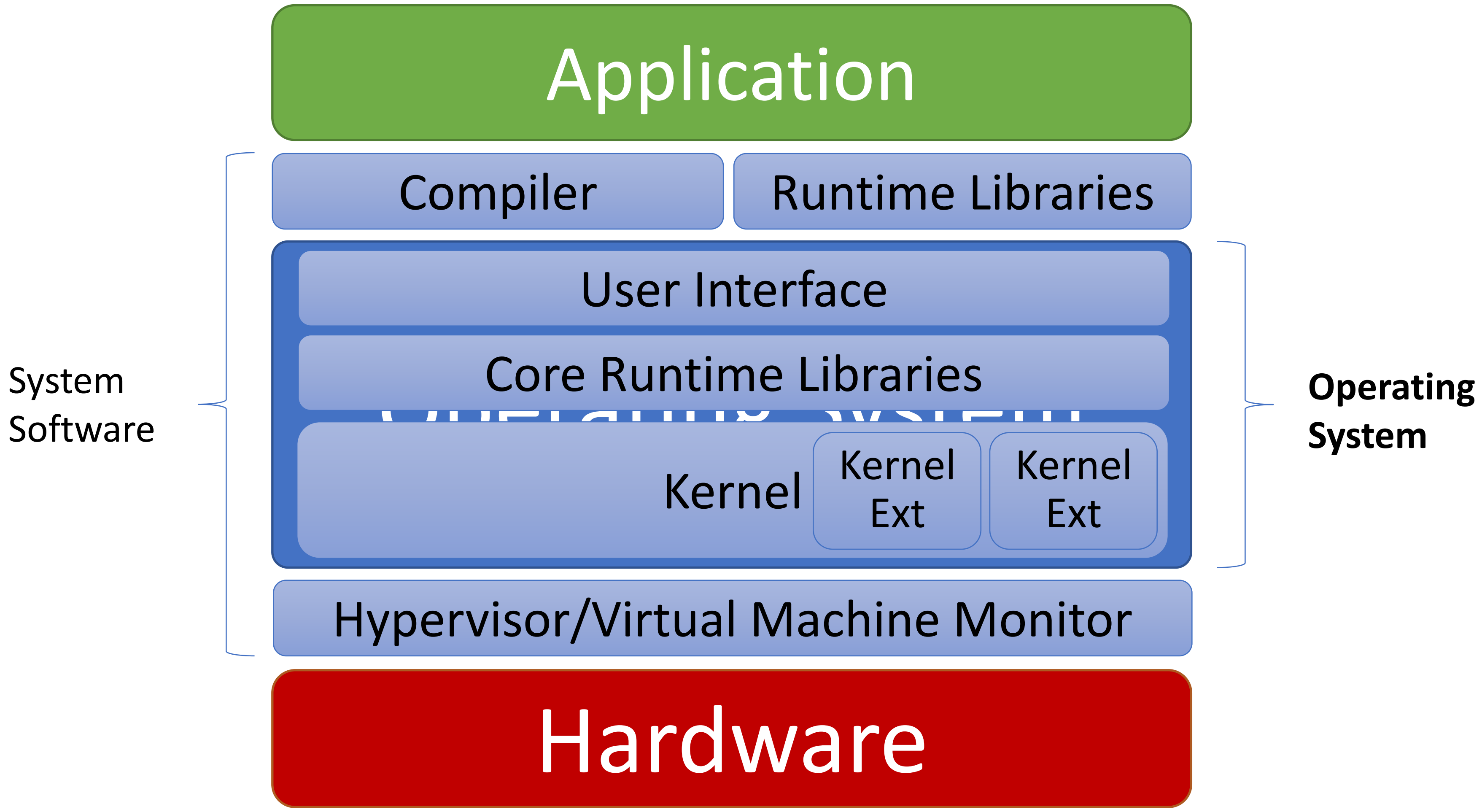
The Traditional Picture

- **“The OS is everything you don’t need to write in order to run your application”**
- Think OS as a library
  - In some ways, it is
    - all operations on I/O devices require OS calls (*syscalls*)
  - In other ways, it isn't
    - you use the CPU/memory without OS calls
    - it intervenes without having been explicitly called

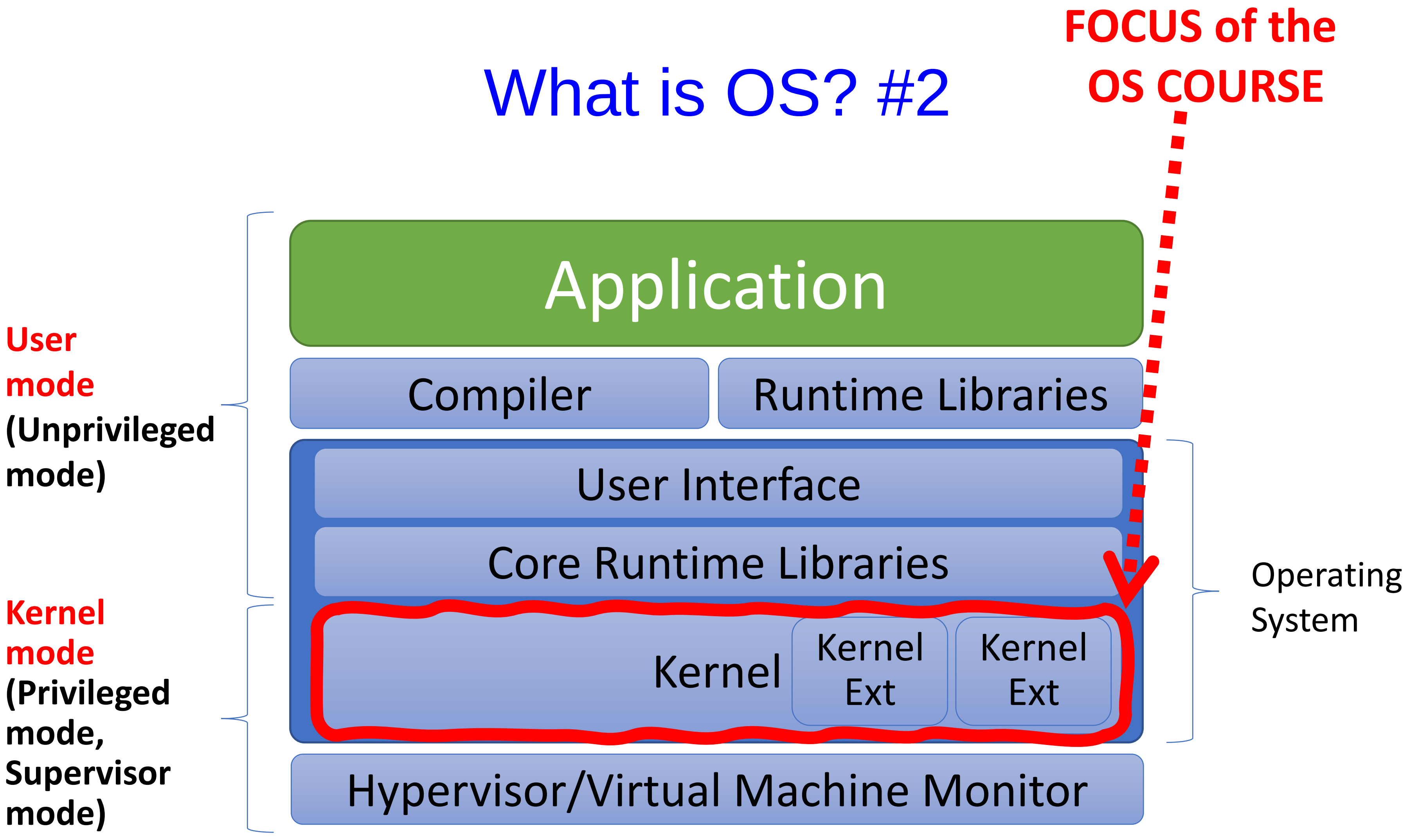


https://en.wikipedia.org/wiki/File:Operating_system_placement.svg

What is OS? #1


Application
Compiler
Runtime Libraries
User Interface
Core Runtime Libraries
Kernel
Kernel Ext
Kernel Ext
Hypervisor/Virtual Machine Monitor
Hardware
System Software
Operating System

What is OS? #2



NOTE there exist OSes that do not use modes, there is hardware that doesn't support modes

The OS and Hardware

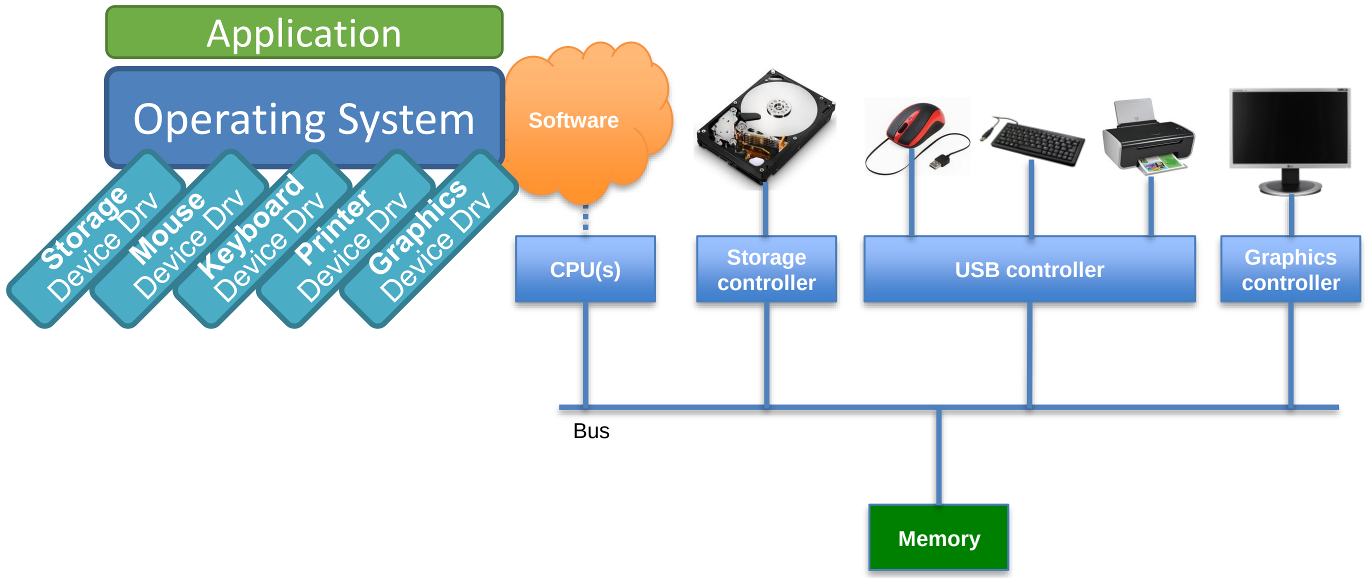
- An OS mediates programs' access to hardware resources (*sharing* and *protection*)
  - computation (CPU)
  - volatile storage (memory) and persistent storage (disk, etc.)
  - network communications (TCP/IP stacks, Ethernet cards, etc.)
  - input/output devices (keyboard, display, sound card, etc.)
- The OS abstracts hardware into logical resources and well-defined interfaces to those resources (*ease of use*)
  - processes (CPU, memory)
  - files (disk)
  - sockets (network)

Why Bother with an OS?

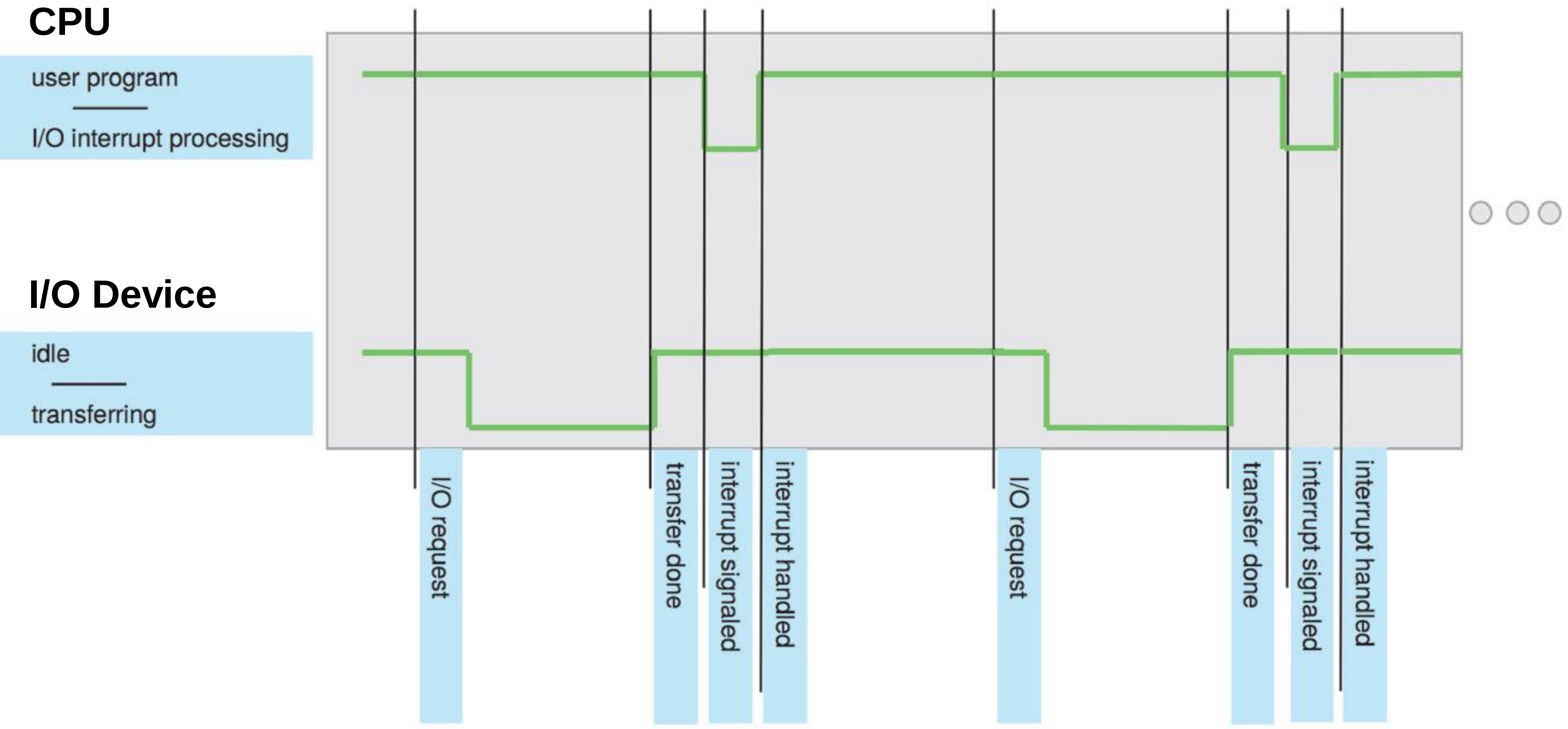
- Application benefits
  - programming simplicity
    - see high-level abstractions (files) instead of low-level hardware details (device registers)
    - abstractions are reusable across many programs
  - portability (across machine configurations or architectures)
    - device independence: 3com card or Intel card?
- User benefits
  - safety
    - program "sees" its own (virtual) machine, thinks it "owns" the computer
    - OS protects programs from each other
    - OS fairly multiplexes resources across programs
  - efficiency (cost and speed)
    - share one computer across many users
    - concurrent execution of multiple programs

Hardware Recap: Devices

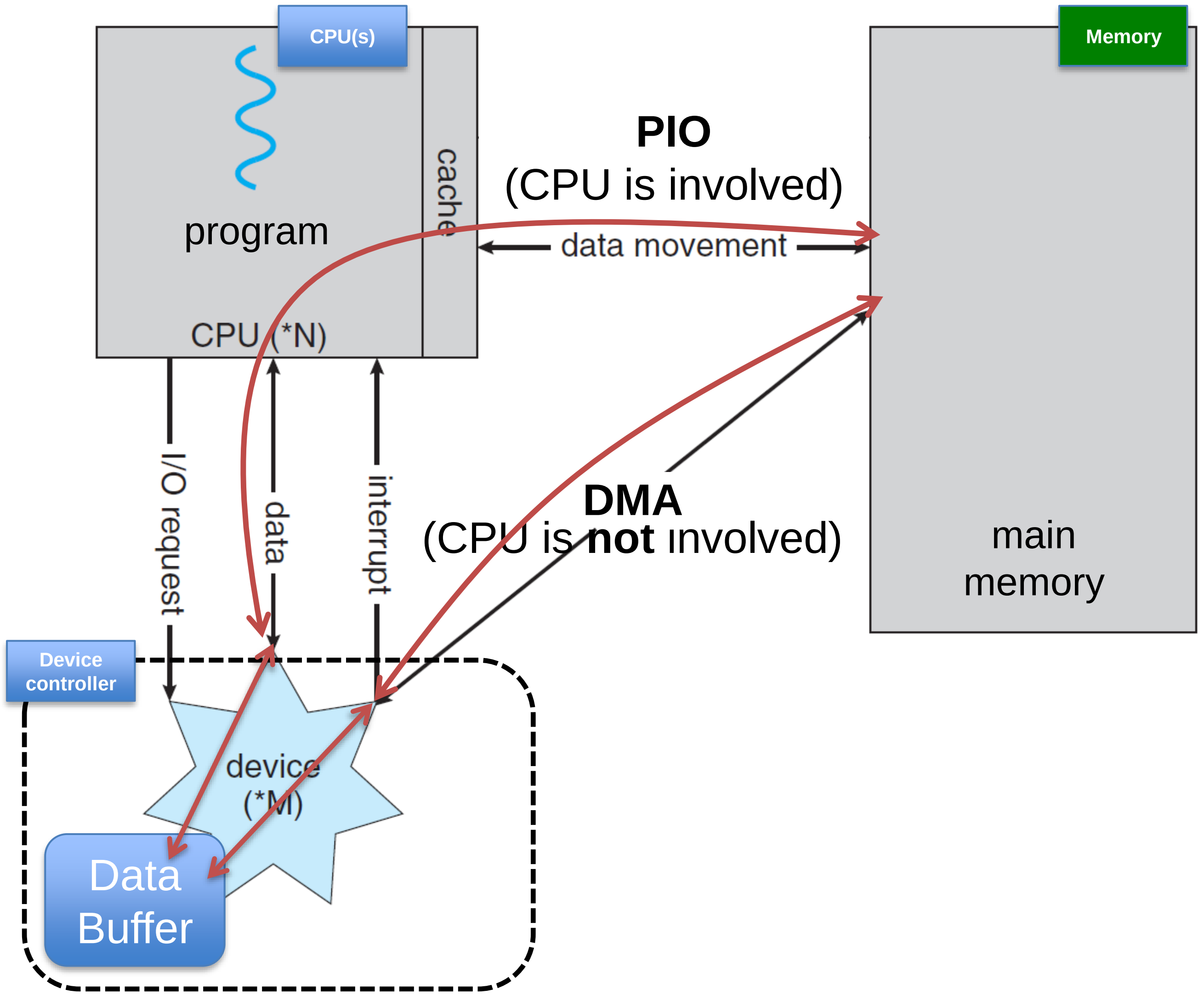
- To interact with the external world (e.g., with the user)
- Every device has a device controller, which
  - May move data to main memory, like the CPU(s)
  - Run in parallel to the CPU
  - Have buffers for data (thus, local memory)
- Operating Systems have device drivers per device controller



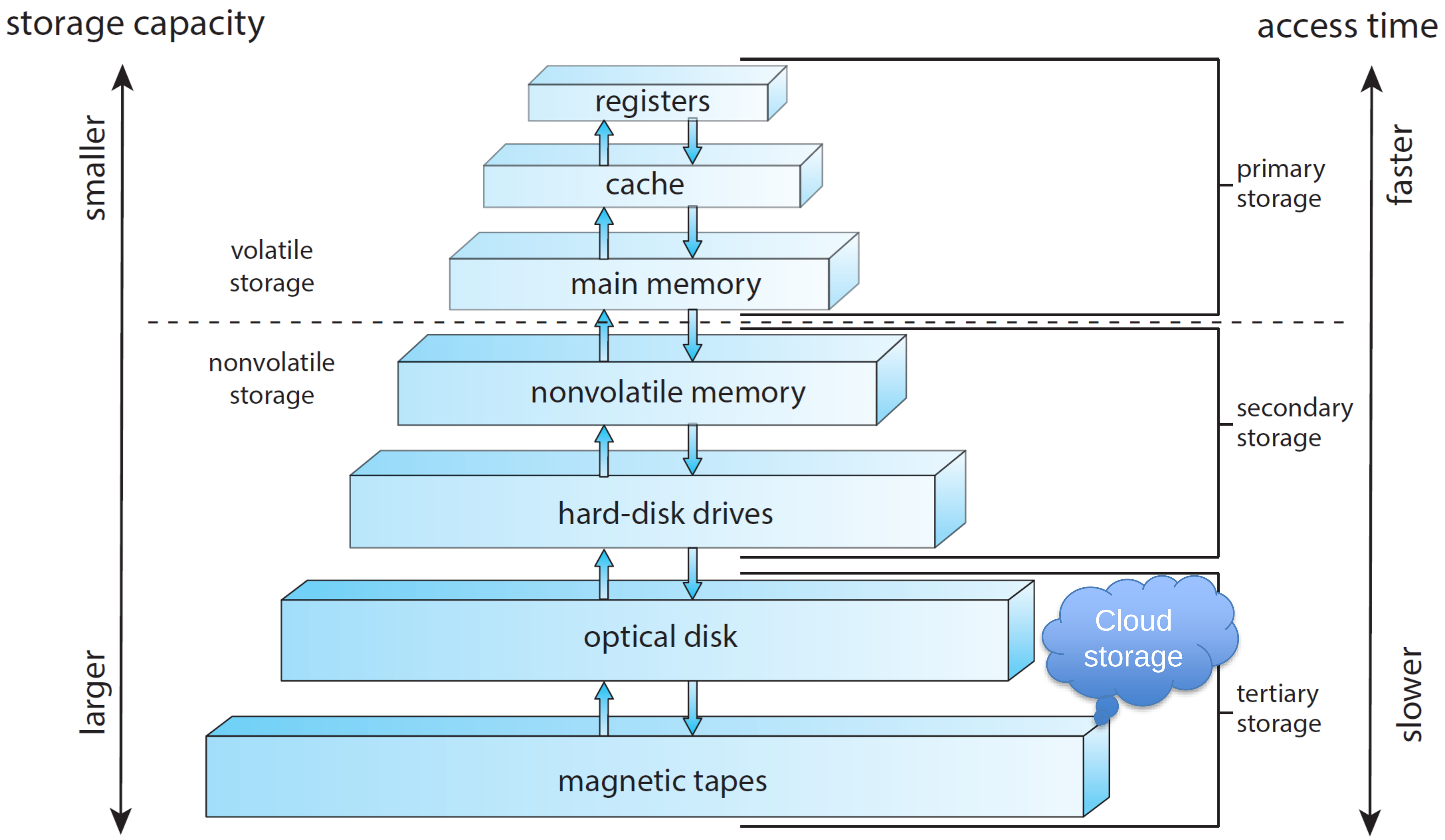
Hardware Recap: Interrupts



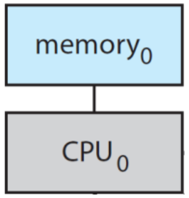
Hardware Recap: DMA



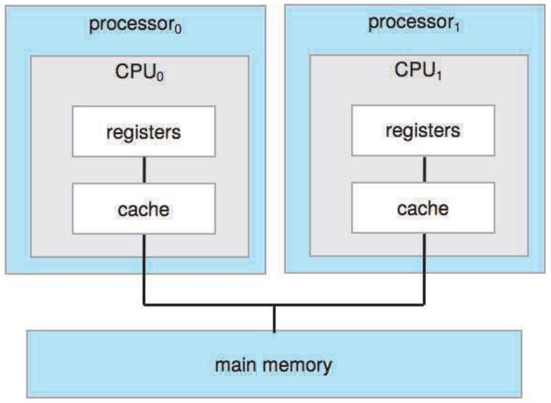
Hardware Recap: Storage Structure



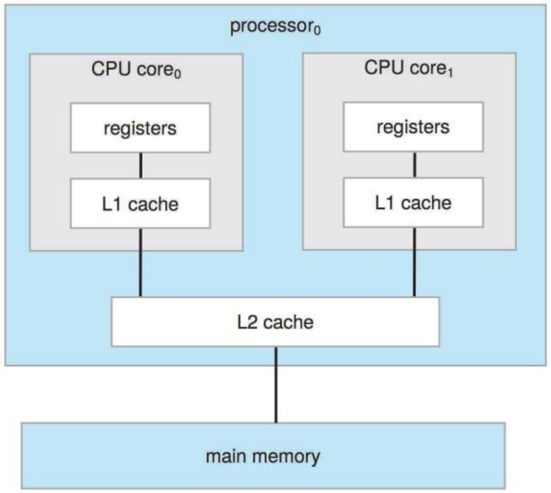
Hardware Recap: Memory and CPU



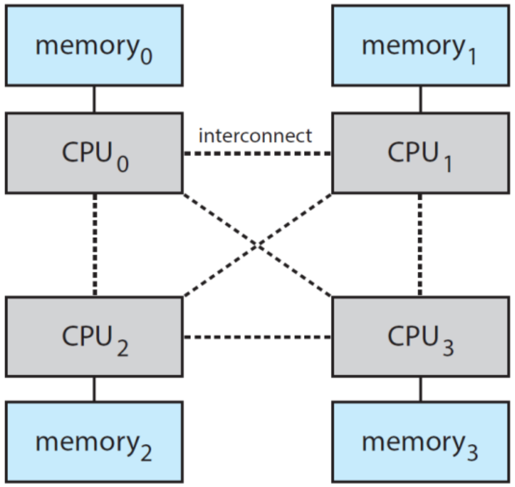
Single-core



Multiprocessor



Multicore



NUMA