Computer System Structures

Notice: The slides for this lecture have been largely based on those accompanying the textbook Operating Systems Concepts with Java, by Silberschatz, Galvin, and Gagne. Many, if not all, the illustrations contained in this presentation come from this source.
Chapter 2: Computer-System Structures

- Computer System Operation
- I/O Structure
- Storage Structure
- Storage Hierarchy
- Hardware Protection
- Network Structure
A Modern Computer System
Computer-System Operation

- I/O devices and the CPU can execute concurrently.
- Each device controller is in charge of a particular device type.
- Each device controller has a local buffer.
- CPU moves data from/to main memory to/from local buffers.
- I/O is between the device to the local buffer of controller.
- Device controller informs CPU that it has finished its operation by causing an interrupt.
Common Functions of Interrupts

- Interrupts transfer control to the interrupt service routine generally through the *interrupt vector*, which contains the addresses of all the service routines.
- Interrupt architecture must save the address of the interrupted instruction.
- Incoming interrupts are *disabled* while another interrupt is being processed to prevent a *lost interrupt*.
- A *trap* is a software-generated interrupt caused either by an error or a user request.
- An operating system is *interrupt* driven.
# Interrupt Handling

- The operating system preserves the state of the CPU by storing registers and the program counter.

- The OS determines which type of interrupt has occurred:
  - polling,
  - vectored interrupt system.

- Separate kernel routines determine what action should be taken for each type of interrupt.
I/O Systems

I/O subsystem hides peculiarities of devices from rest of system. It contains:

- Memory management component
- General device driver interface
- Drivers for specific hardware devices
DMA Structure

- Used for high-speed I/O devices able to transmit information at close to memory speeds.

- Device controller transfers blocks of data from buffer storage directly to main memory without CPU intervention.

- Only on interrupt is generated per block, rather than the one interrupt per byte.
Storage Structure

- **Main memory** – the only large storage media that the CPU can access directly.

- **Secondary storage** – extension of main memory that provides large nonvolatile storage capacity.

- **Magnetic disks** – rigid metal or glass platters covered with magnetic recording material:
  - Disk surface is logically divided into *tracks*, which are subdivided into *sectors*,
  - The *disk controller* determines the logical interaction between the device and the computer.
Storage Hierarchy

- Storage systems organized in hierarchy:
  - Speed,
  - Cost,
  - Volatility.

- *Caching* – copying information into faster storage system; main memory can be viewed as a last cache for secondary storage.
Caching

- Use of high-speed memory to hold recently-accessed data.

- Requires a *cache management* policy

- Caching introduces another level in storage hierarchy:
  - This requires data that is simultaneously stored in more than one level to be *consistent*. 
From Disk to Register

Consider a system with virtual memory in which an integer variable A has been swapped out of main memory and currently resides on disk. Consider that a machine instruction moves that variable from memory into a register.

**Question:** What is the sequence of events that ensues until the value of A is finally stored in a register?