

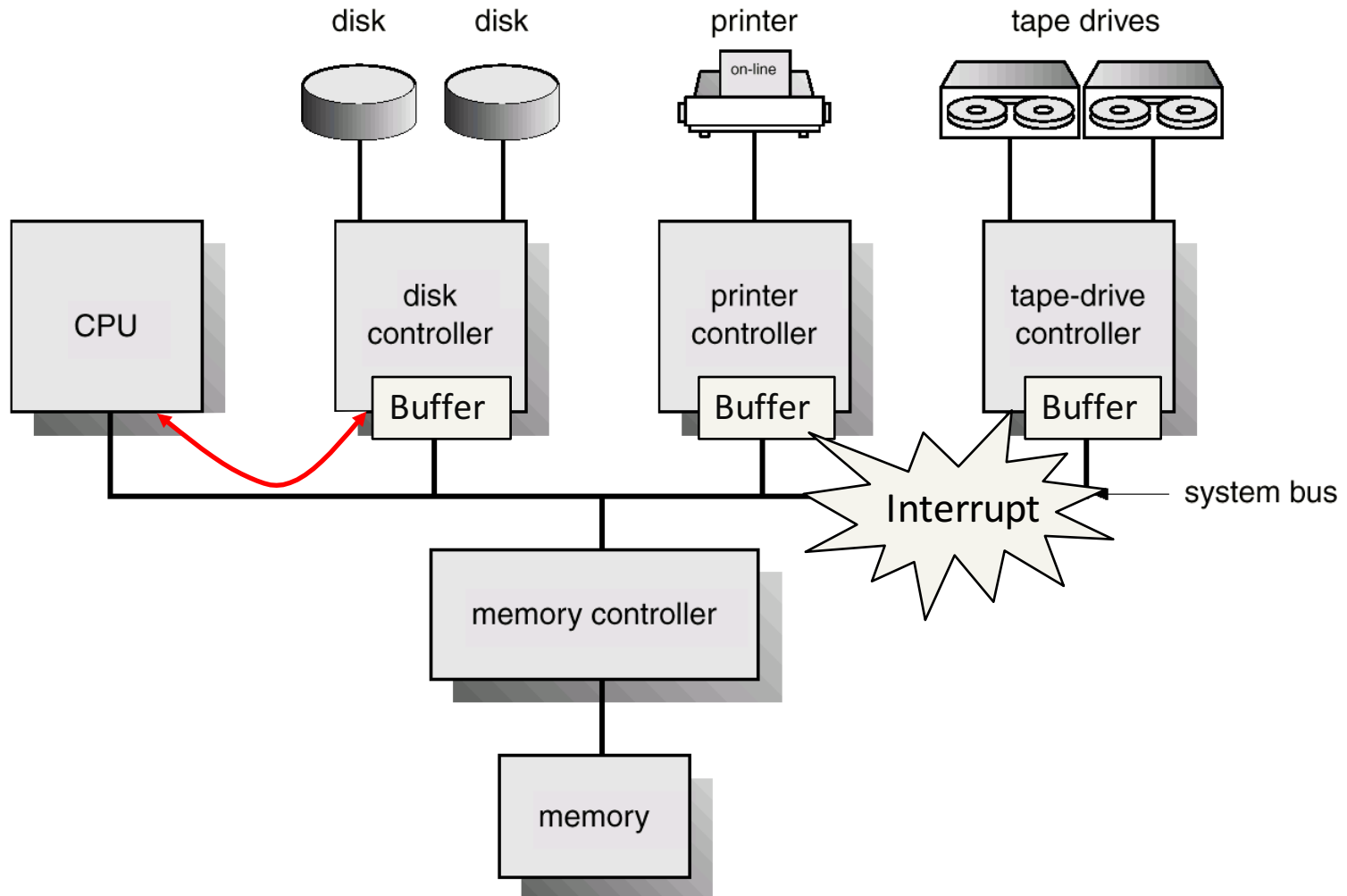
1. Review the following concepts on Computer System Operation, and explain how they are related to Operating Systems.

a) **Computer Organization**

b) Interrupts

c) I/O Structure: Interrupt-Driven Data Transfer, Direct Memory Access (DMA) Data Transfer

# Computer Organization



- Computer Organization

- What is a device controller?

Each device controller is in charge of the operations for a particular device type.

- What is the channel through which devices and the CPU communicate?

A system bus.

- How do devices notify CPU that I/O operations are done?

Interrupt.

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# Interrupt

- Why do we say “Operating systems are interrupt driven”?

If there are no interrupts, OS will not execute (idle).

- What are the major steps of interrupt handling?

Three steps:

- First, OS saves the state of the current execution.
- Second, it determines the interrupt service routine according to the interrupt type.
- Third, the interrupt service routine is executed.

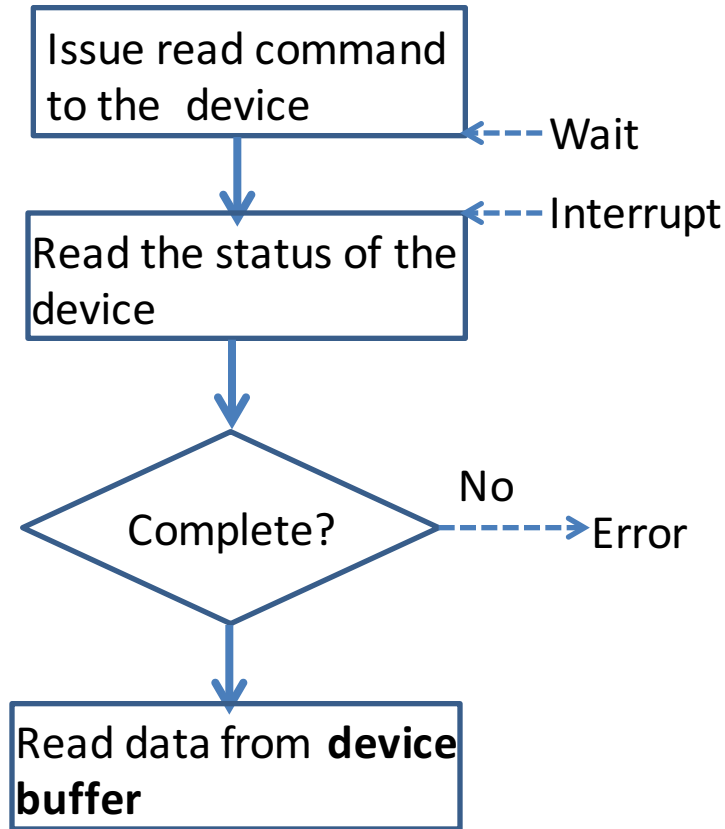
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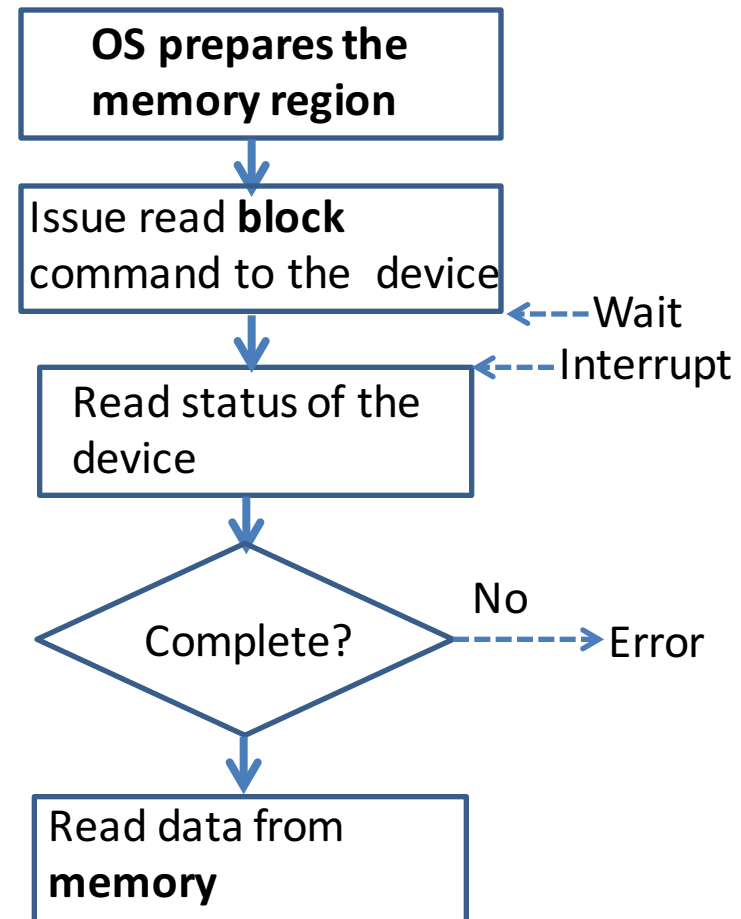
c) **I/O Structure: Interrupt-Driven Data Transfer, Direct Memory Access (DMA) Data Transfer**

# What are Major Differences between Interrupt Driven I/O and DMA?



(a) Interrupt driven I/O

- **Small size I/O**
- **More Interrupts**
- **Low-speed devices**



(b) DMA

- **Block based I/O**
- **Less interrupts**
- **High-speed devices**

2. Indicate whether the following statements are true or false. Justify your answers.

- a) All I/O instructions are privileged instructions.
- b) Given a base register value of 0x1000 and a limit register value of 0x1000, access to memory location 0x1FFF will generate a trap.
- c) Popular operating systems for personal computer use (such as Windows and Linux) are real-time systems.
- d) A system call always generates a trap.



2a) All I/O instructions are privileged instructions.

→ True.

*Justification:* I/O operations must go through OS to ensure their correctness and legality.

2b) Given a base register value of 0x1000 and a limit register value of 0x1000, access to memory location 0x1FFF will generate a trap.

→ False.

*Justification: For memory protection, each access to memory by a process must be in the range [base, base+limit-1]. In this case, it translates to the range [0x1000, 0x1FFF]. Hence the access to memory location 0x1FFF will succeed and not generate a trap.*

2c) Popular operating systems for personal computer use (such as Windows and Linux) are real-time systems.

→ False.

*Justification:* Those systems are usually time sharing system.

*More:* Real-time scheduling in e-learning video.

2d) A system call always generates a trap.

→ True.

*Justification:* When a system call is encountered, hardware switches from user to kernel mode and generates a trap. The appropriate system call function in the kernel is then identified and executed.

3. Distinguish between multiprogramming and multiprocessing. What were the key motivations for the development of each?

# Multiprogramming vs. Multiprocessing

- Multiprogramming refers to the running of **more than one program** concurrently in a computer system (even if it has only a single-core CPU).
  - Goal: improve CPU utilization.
- Multiprocessing is the execution of programs on a computer system comprised of **more than one processing cores (multi-core CPU)**.
  - Goal: increase computing power with **parallel** architectures.

# Multiprogramming vs. Multiprocessing (cont')

Process: Order → Wait till food is ready → Get food

- User A: buy chicken wings
- User B: buy noodles



VS.



Multiprogramming shop

Multiprocessing shop

