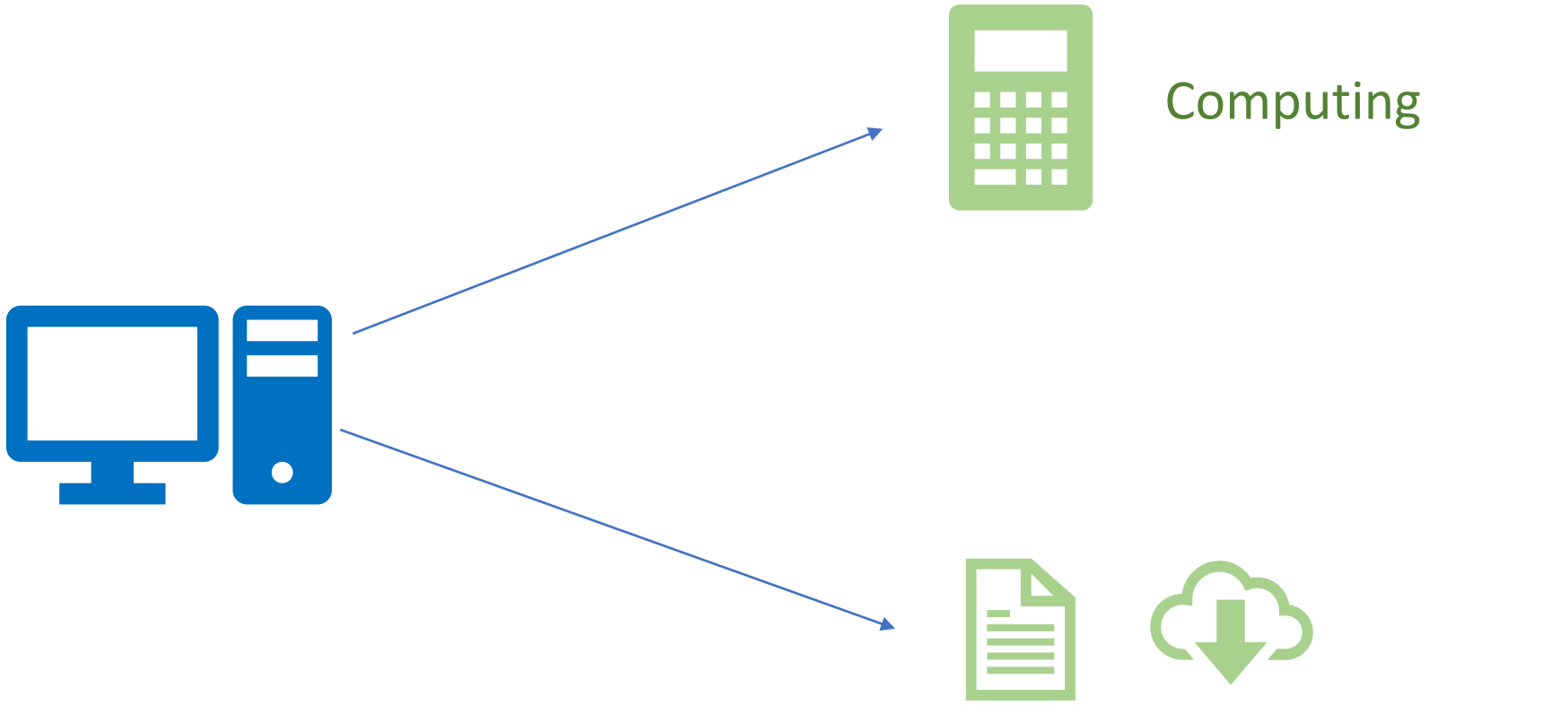
# I/O Systems

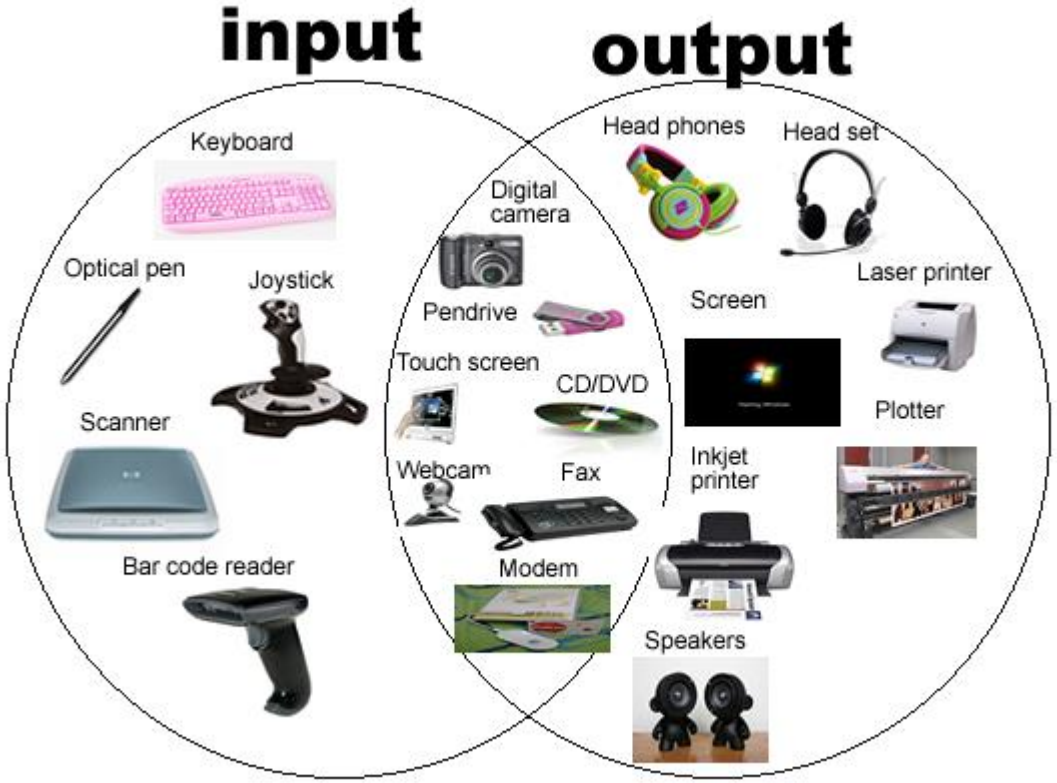
CS3600 Spring 2022

# I/O Intro



# I/O Devices

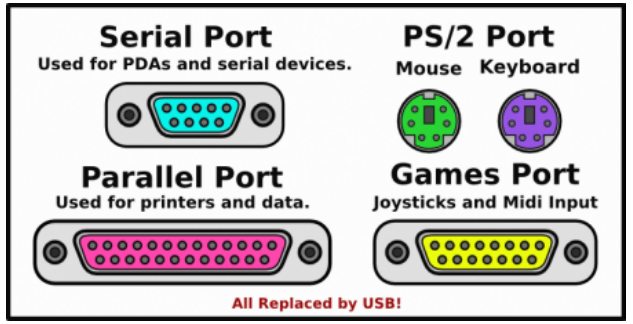
- Like system calls that connects between applications and operating system.
- Device drivers present a device-access interface

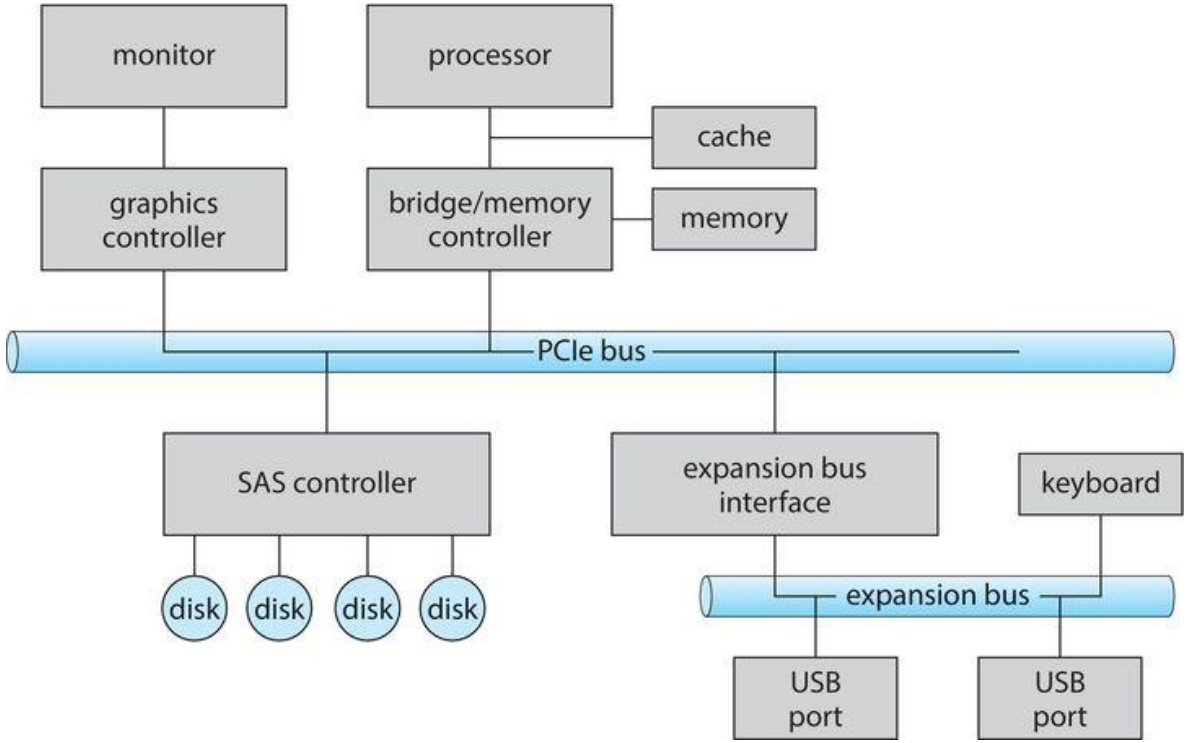


# I/O Hardware

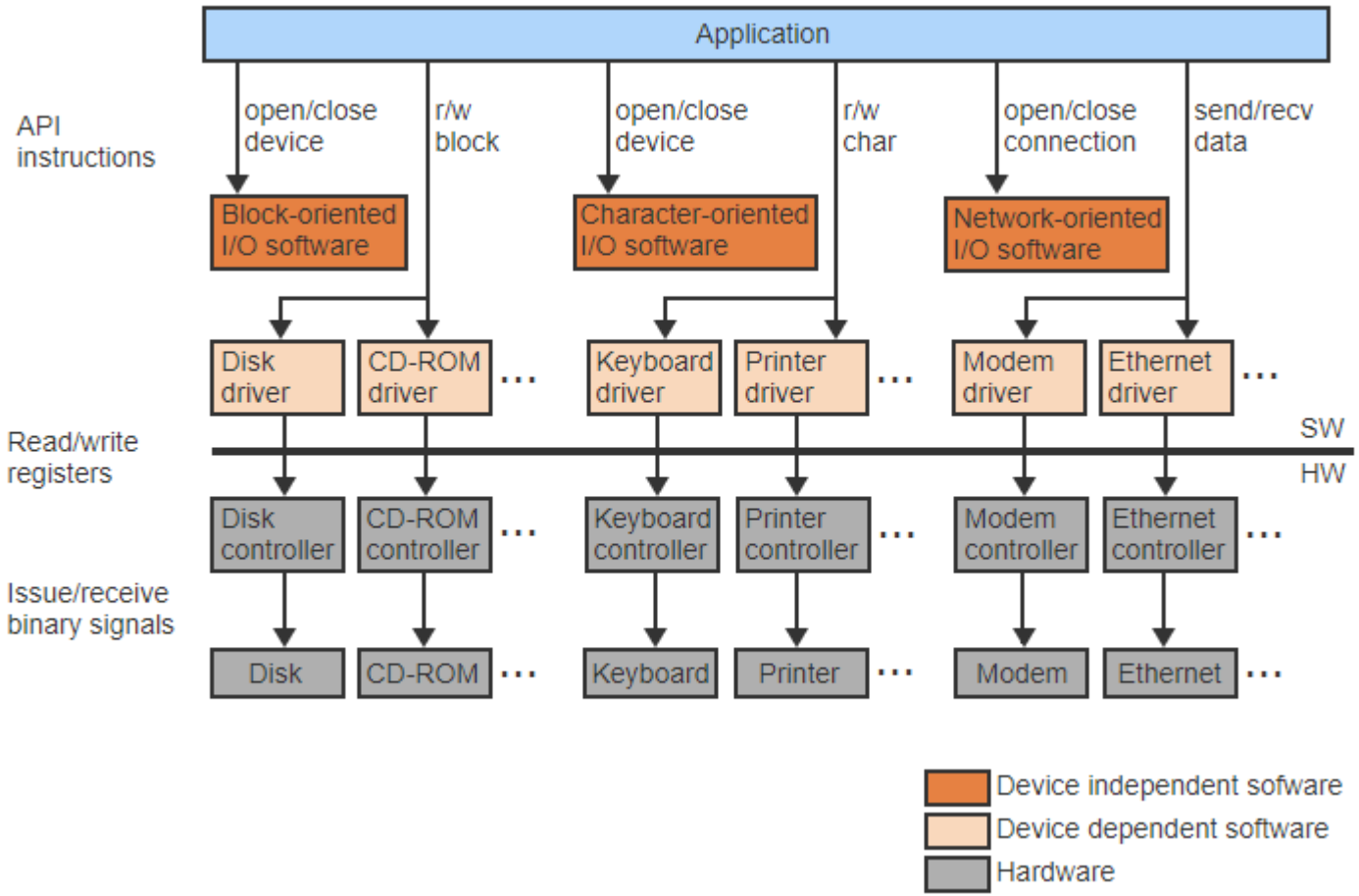
- Devices:  Wired or wireless

- Connection:  port, bus



# I/O

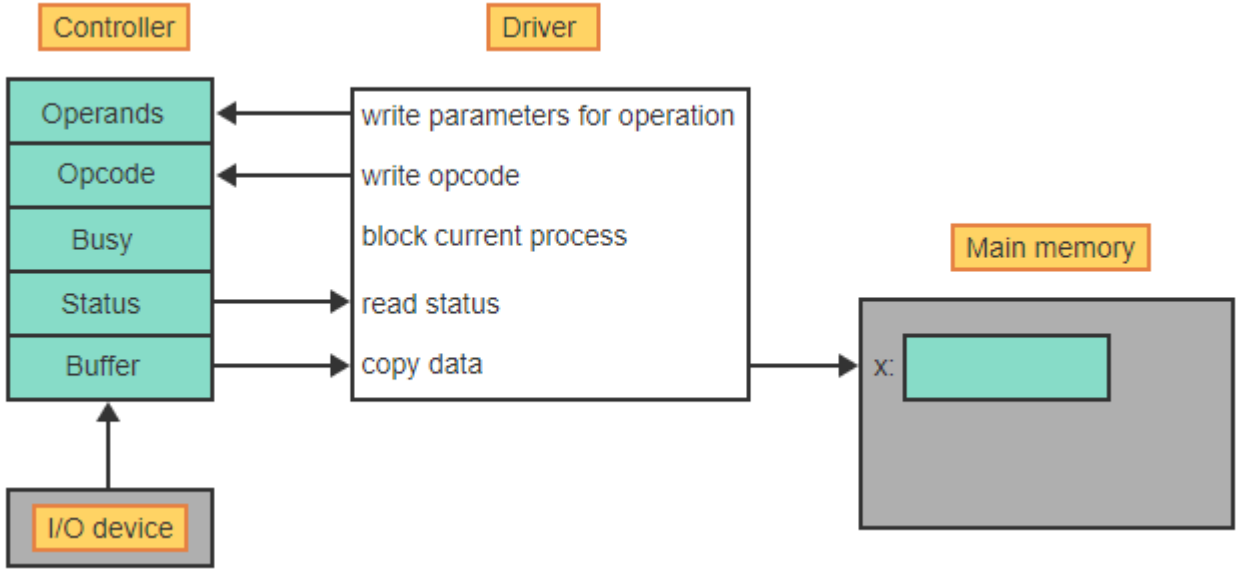

Application
API instructions
open/close device
r/w block
open/close device
r/w char
open/close connection
send/recv data
Block-oriented I/O software
Character-oriented I/O software
Network-oriented I/O software
Disk driver
CD-ROM driver
Keyboard driver
Printer driver
Modem driver
Ethernet driver
Read/write registers
SW
HW
Disk controller
CD-ROM controller
Keyboard controller
Printer controller
Modem controller
Ethernet controller
Issue/receive binary signals
Disk
CD-ROM
Keyboard
Printer
Modem
Ethernet
Device independent sofware
Device dependent software
Hardware

# Programmed Input with Polling

- Programmed I/O: CPU, running the device driver, performs the copying of all data between the I/O device controller and main memory.

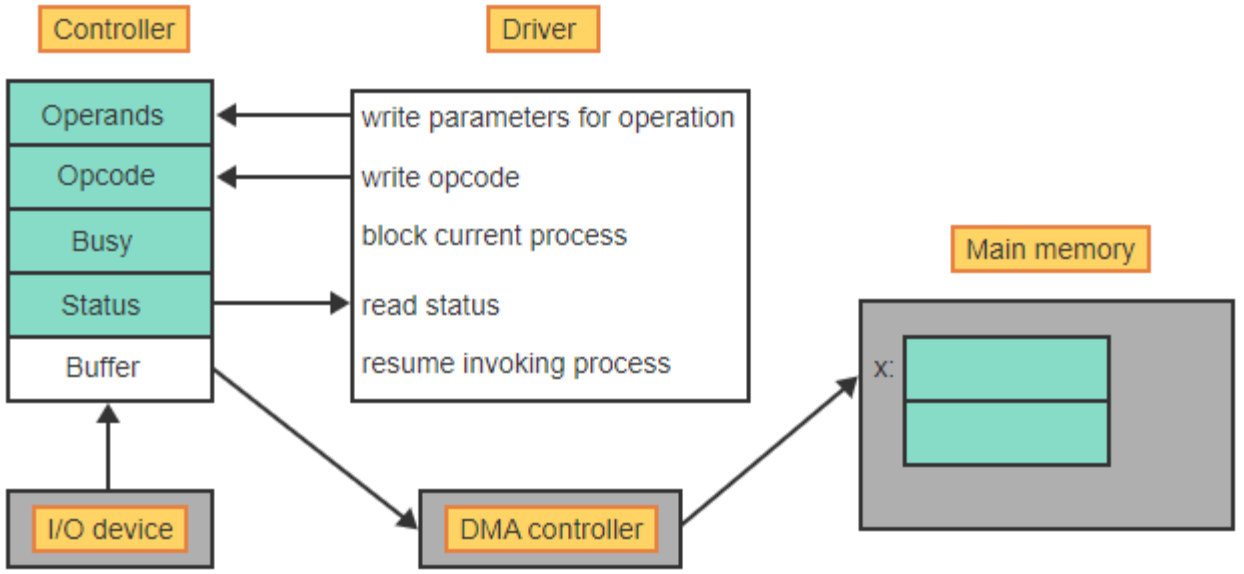
- Polling: Checking if the device is available.

# Programmed Input with Interrupts



# I/O with direct memory access

***Direct memory access*** (***DMA***) controller is a hardware component that allows devices to access main memory directly



# Q1

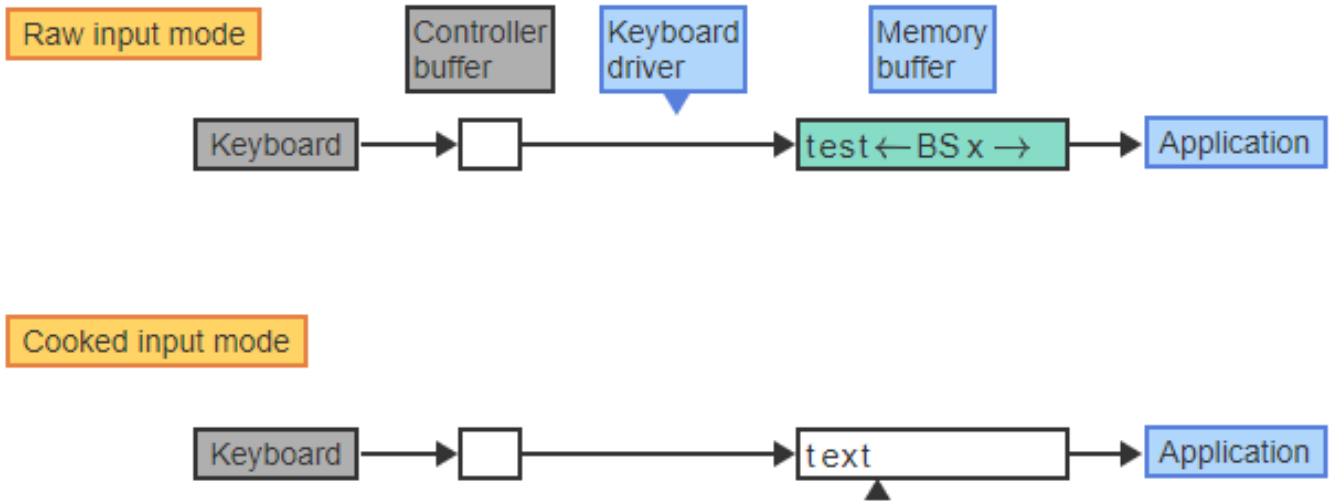
- A fast laser printer produces 20 pages per minute, where a page consists of 4000 characters. The system uses interrupt-driven I/O, where processing each interrupt takes 50 µsec.
- How much overhead will the CPU experience if the output is sent to the printer one character at a time?

# Q2

- A mouse generates an interrupt whenever the position changes by 0.1 mm.
- How much time does the CPU have to process each interrupt if the mouse moves at a speed of 30 cm/second?

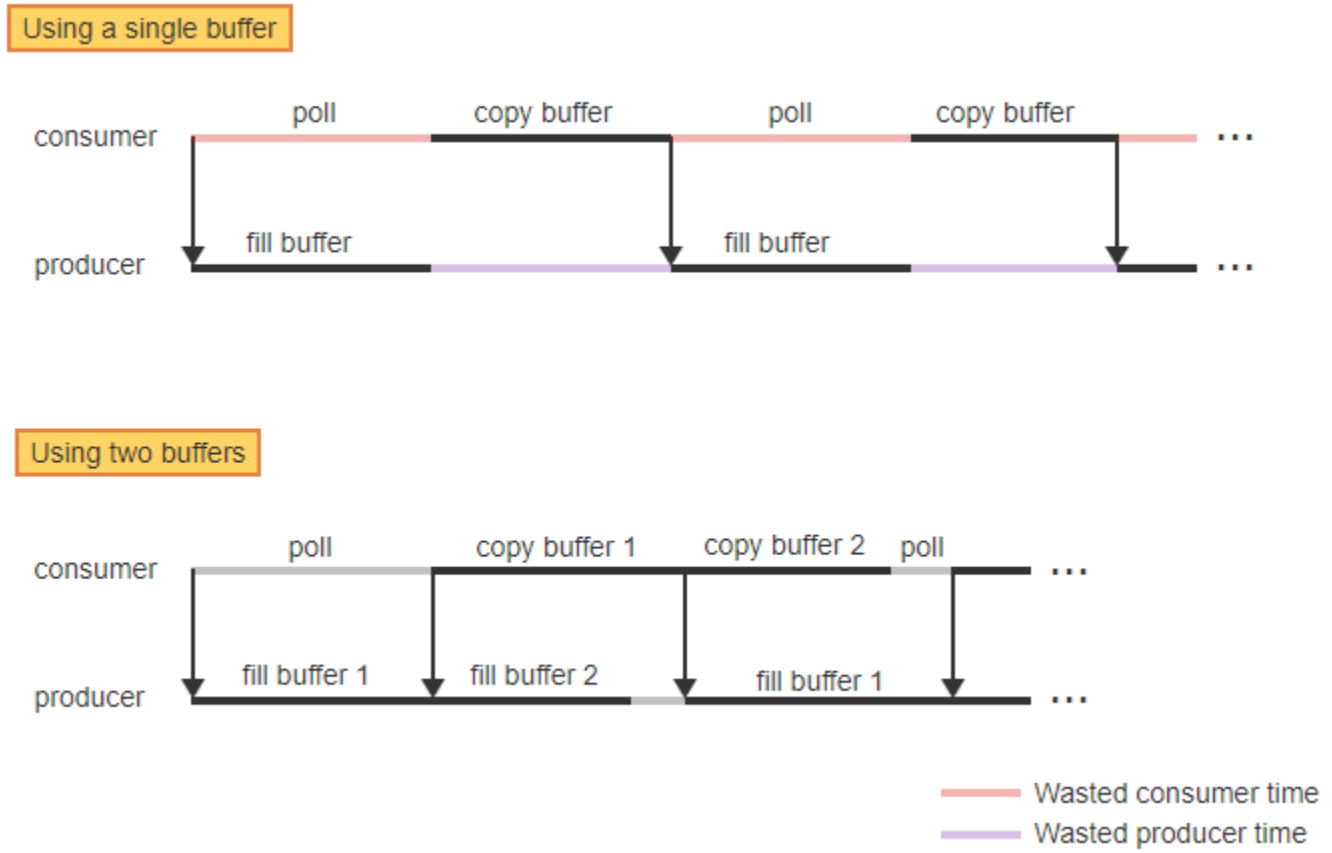
# Data Buffering & Caching

- A ***buffer***, is a memory area that stores data being transferred between two devices or between a device and an application



# Buffer Swapping

- ***Buffer swapping*** is a technique that allows the operations of a producer process and a consumer process to overlap by using two buffers.



# Circular Buffer

- A ***circular buffer*** is a fixed array of buffer slots filled by the producer and emptied by the consumer one slot at a time in ascending order.

# Q2 -solution

Mouse moves at a speed of 30 cm/second = 300mm/s

An interrupt is generated every 0.1 mm

Number of interrupts in one second = 300 / 0.1 = 3000

# Q1 -solution

20 pages per minute =20 X 4000 = 80000 characters/ minute

= 1333 characters/ second

Interrupt for each character = 50 microseconds

Total time for interrupt =1333 X 50 X $10^{-6}$ = 0.066 sec