

**Tishk International University**  
**Applied Science Faculty**  
**IT Department**



# Computer Hardware

## Lecture 03: Standard Input and Output Systems

**2nd Grade – Fall Semester**

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# Lecture 03: Standard Input and Output Systems



# Agenda

- Input/Output Subsystem
- Modes of I/O Data TransferEthernet NICs
  - Programmed I/O
  - Interrupt Initiated I/O
  - Direct Memory Access (DMA)
- I/O Processor (IOP)
- Input Devices
  - Keyboard and Mouse
  - Touch Screen
  - KVM Switch and KVM Extender
  - Scanner
  - Webcam
  - IP Camera
- Output Devices
  - Printer

# Input/Output Subsystem

- In a Computer System, in addition to the CPU and Main Memory, Input/Output (I/O) is a major functional subsystem.
- Input/Output Subsystem provides a mechanism for communication between the CPU and the external world.
- I/O subsystem connects the external devices like Keyboard, Mouse, Monitor, Joystick, and internal devices like Hard Disk, CD to the Computer. Internet connection is also part of the I/O.

# Modes of I/O Data Transfer

- Data transfer modes between the CPU and I/O devices are given below:
  1. Programmed I/O
  2. Interrupt Initiated I/O
  3. Direct Memory Access (DMA)

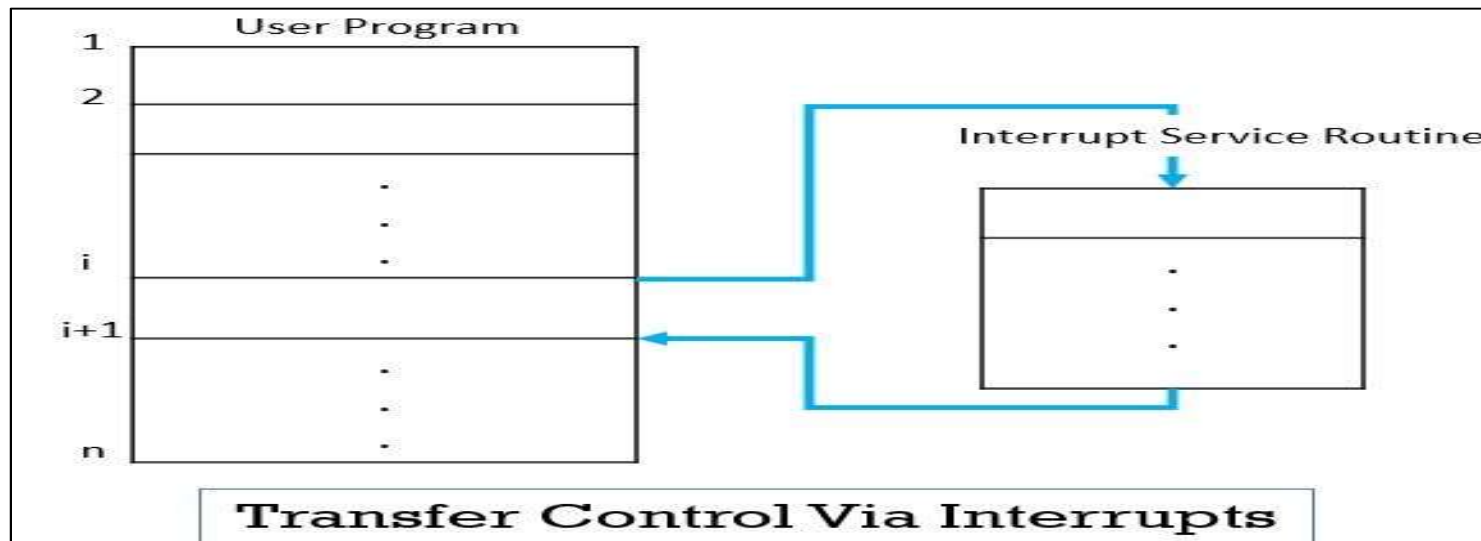
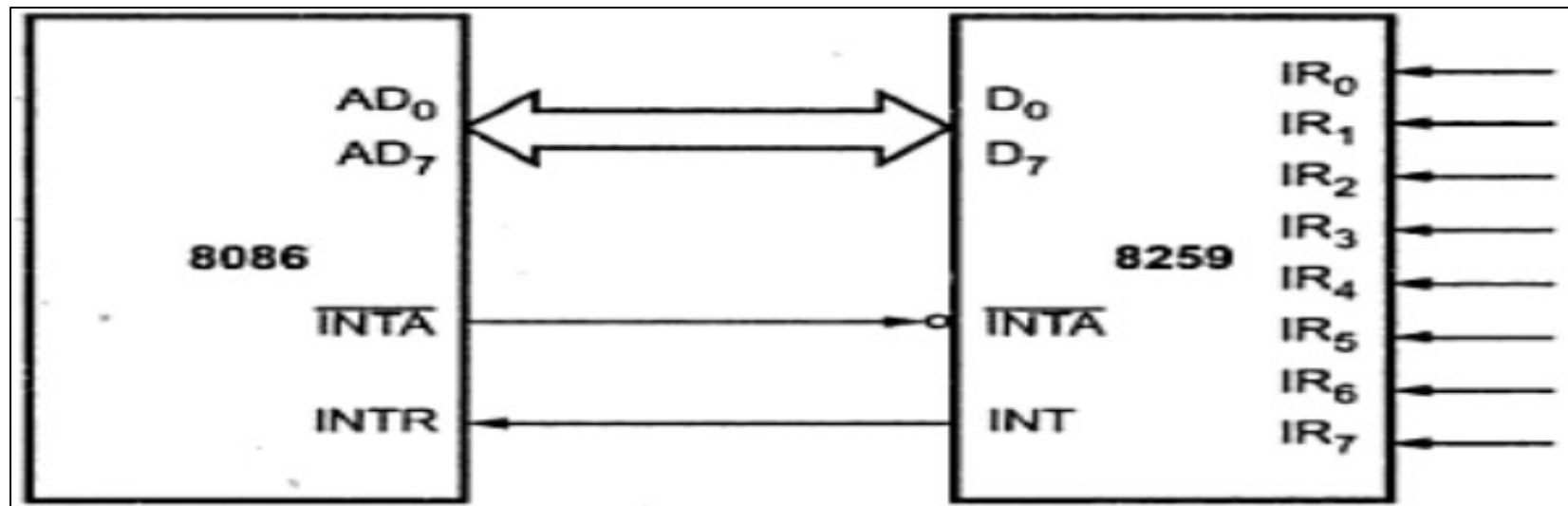
# 1. Programmed I/O

- Programmed I/O data transfers are the result of I/O instructions written in computer program. Each data item transfer is initiated by the instruction in the program.
- Usually the program controls data transfer to and from CPU and peripheral. Transferring data under programmed I/O requires **constant monitoring** of the peripherals by the CPU.
- So in this mode the CPU stays in the program loop until the I/O unit indicates that it is ready for data transfer. This is **time consuming** process because it keeps the processor busy needlessly.

## 2. Interrupt Initiated I/O

- In this mode when the device determines that it is ready for data transfer, it generates an interrupt signal.
- The **Interrupt Controller** receives the hardware signal then interrupts the CPU and sends the device number to CPU through data bus.
- The CPU does not need to wait for the I/O device, but after receiving the interrupt signal, the CPU stops the task which it is processing and service the I/O transfer from that device and then returns back to its previous processing task,
- How does the CPU know which one of the Interrupt Functions to execute when there is more than one device?
  - Using the **Interrupt Service Vectors**: address of interrupt service routines, commonly kept in special jump table.

# Interrupt Mechanism Hardware and Software (not required in the exam)

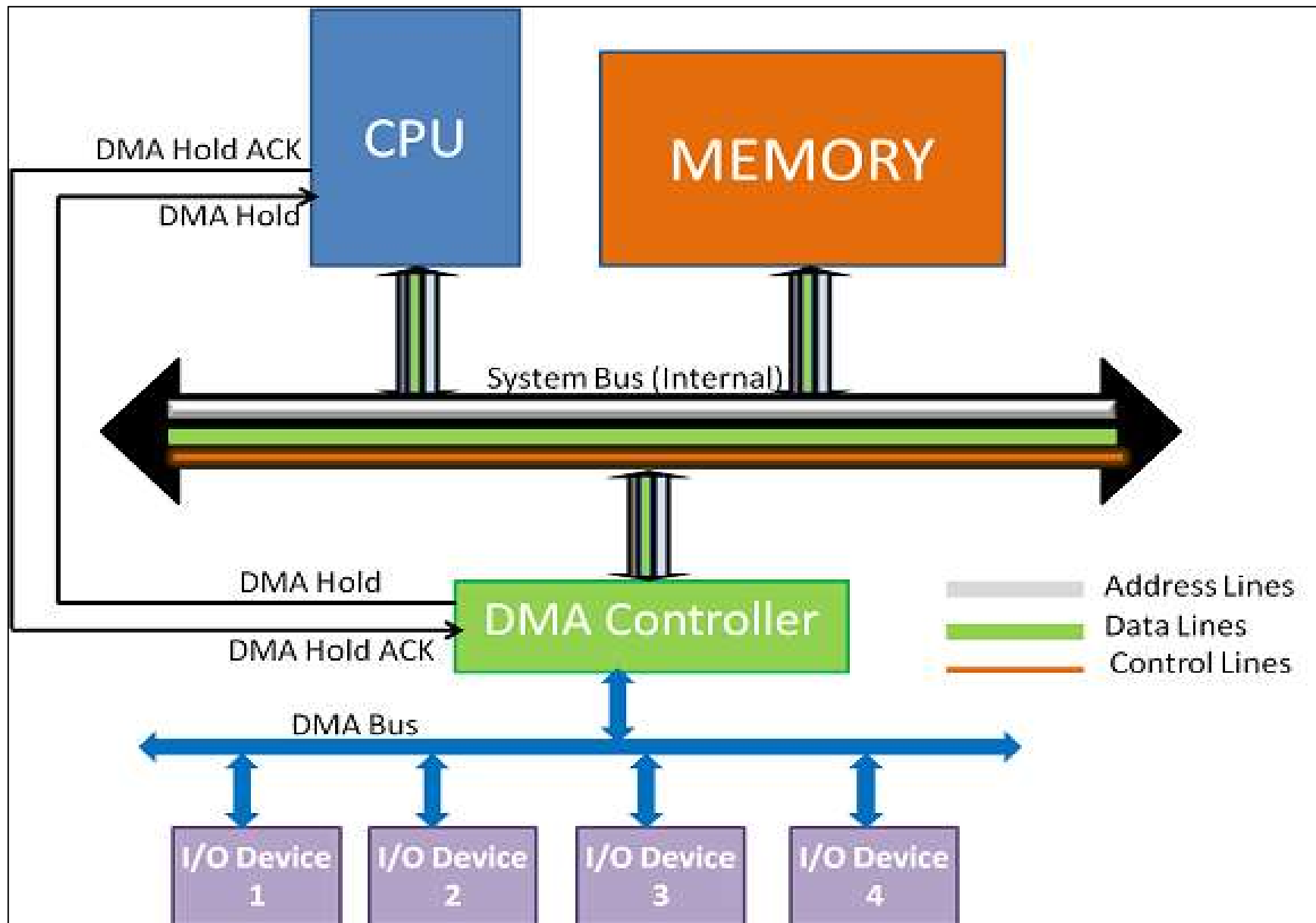




### 3. Direct Memory Access (DMA)

- In this mode a separate device called **DMA Controller** transfers the data between memory and I/O devices without CPU intervention.
- CPU sets up transfer with DMA controller; then transaction occurs without CPU.
- During the DMA transfer, the CPU is idle and has no control of the memory buses. A DMA controller takes over the buses to manage the transfer directly between the I/O device and memory.

# Block Diagram of DMA



# Device Resources Example (not required in the exam)

The screenshot shows the 'Intel(R) HD Graphics Family Properties' dialog box, specifically the 'Resources' tab. The 'Resource settings' section contains a table with the following data:

Resource type	Setting
Memory Range	00000000F7800000 - 00000000F7BFFFFF
Memory Range	00000000E0000000 - 00000000EFFFFFFF
IRQ	0xFFFFFFFF (-6)
I/O Range	F000 - F03F

Below the table, there is a 'Setting based on:' dropdown menu, a checked 'Use automatic settings' checkbox, and a 'Change Setting...' button. At the bottom, the 'Conflicting device list' shows 'No conflicts.' and there are 'OK' and 'Cancel' buttons.

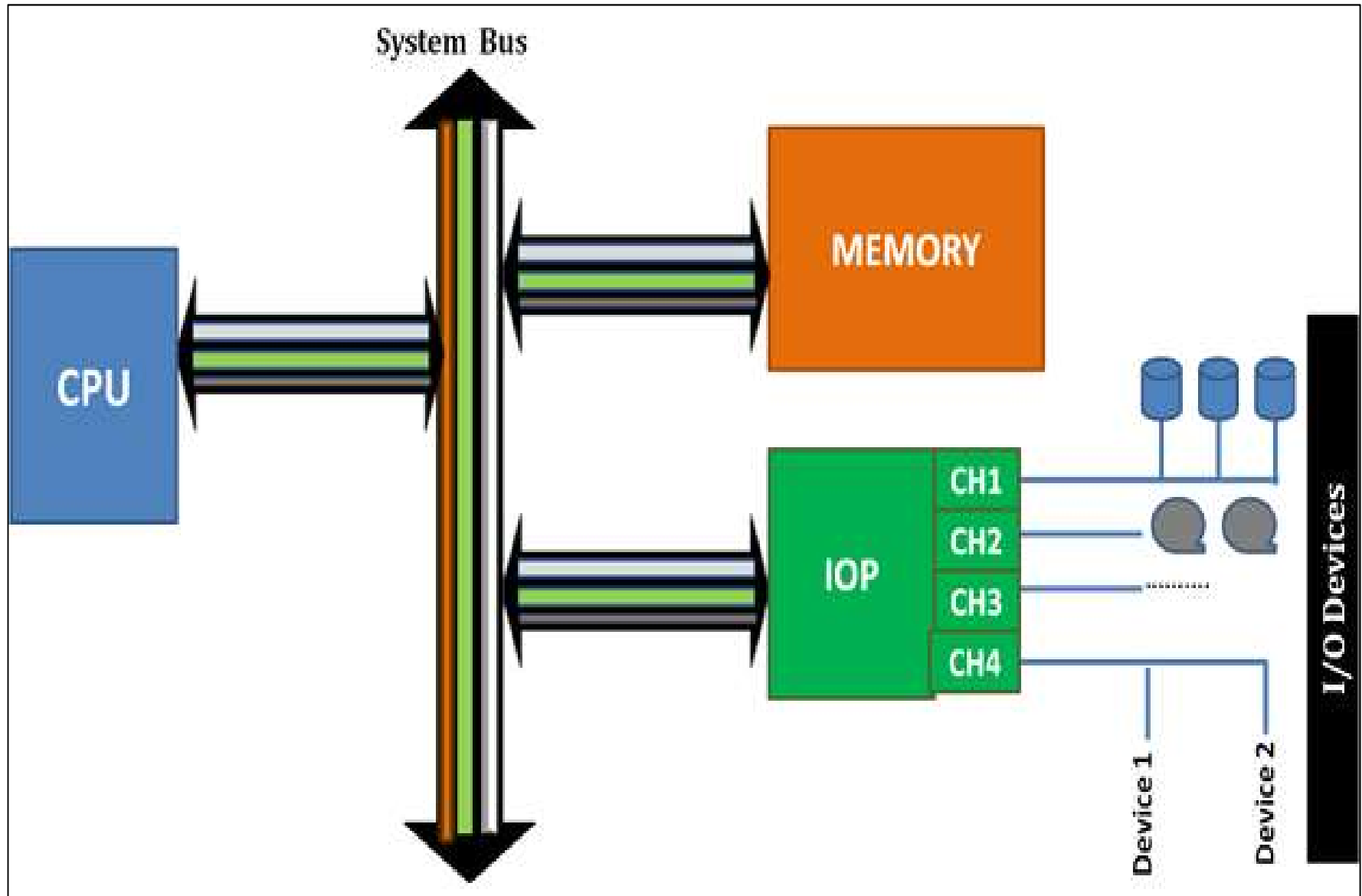
Three red callout boxes with arrows point to specific settings in the table:

- Shared Memory** points to the first 'Memory Range' setting.
- Interrupt** points to the 'IRQ' setting.
- I/O Ports** points to the 'I/O Range' setting.

# I/O Processor (IOP)

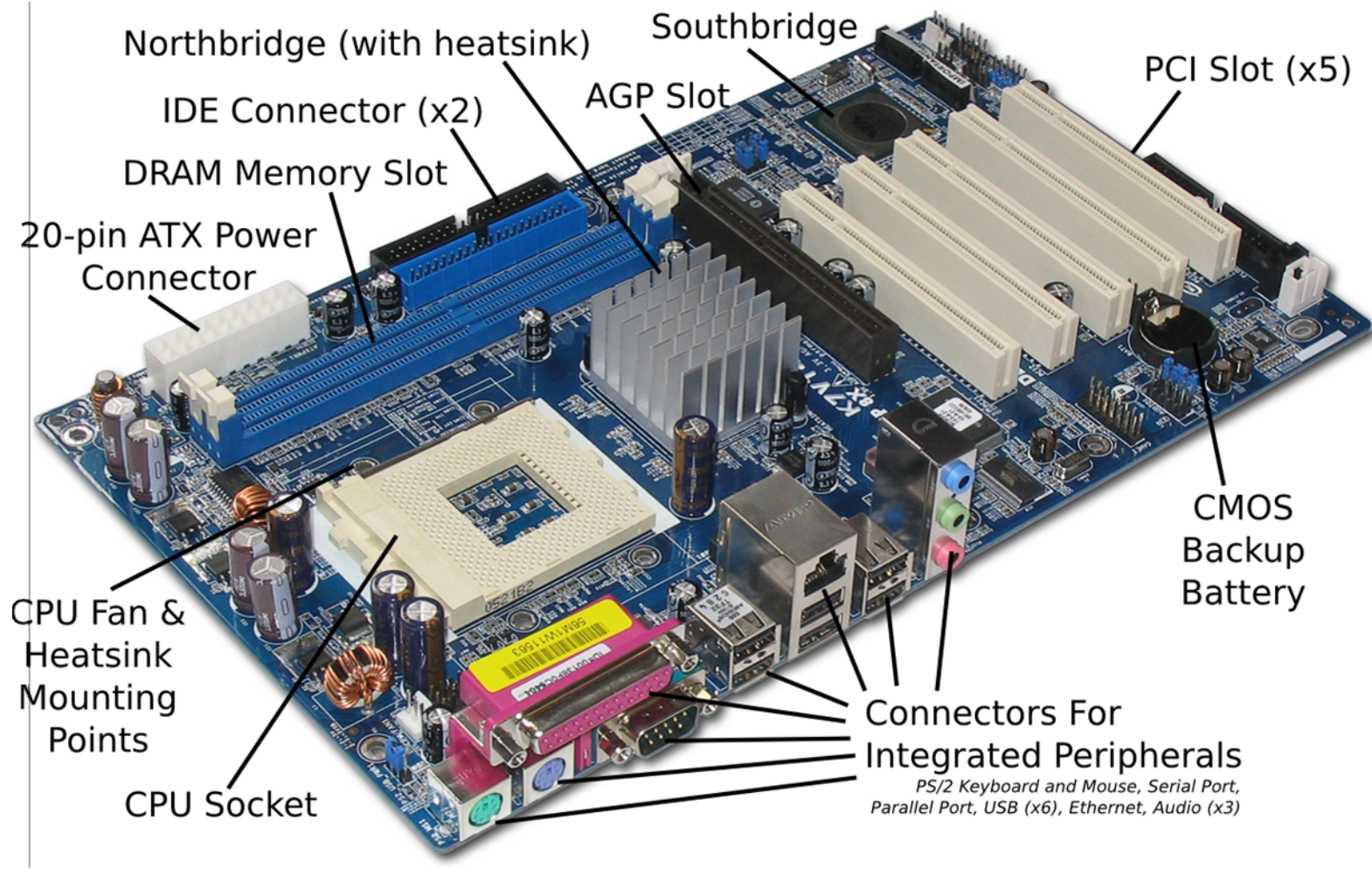
- Independent dedicated I/O processors (smart DMA controllers) that communicates with I/O devices.
- Each IOP uses DMA to communicate with devices
- IOP is similar to CPU except that it is designed to handle the details of I/O operation.
- Unlike DMA controller which is initialized by CPU, IOP can fetch and execute its own instructions, which are specially designed to handle I/O operation.
- I/O processor can be programmed to do complex transfers e.g., programmable network card.

# Block Diagram of I/O Processor



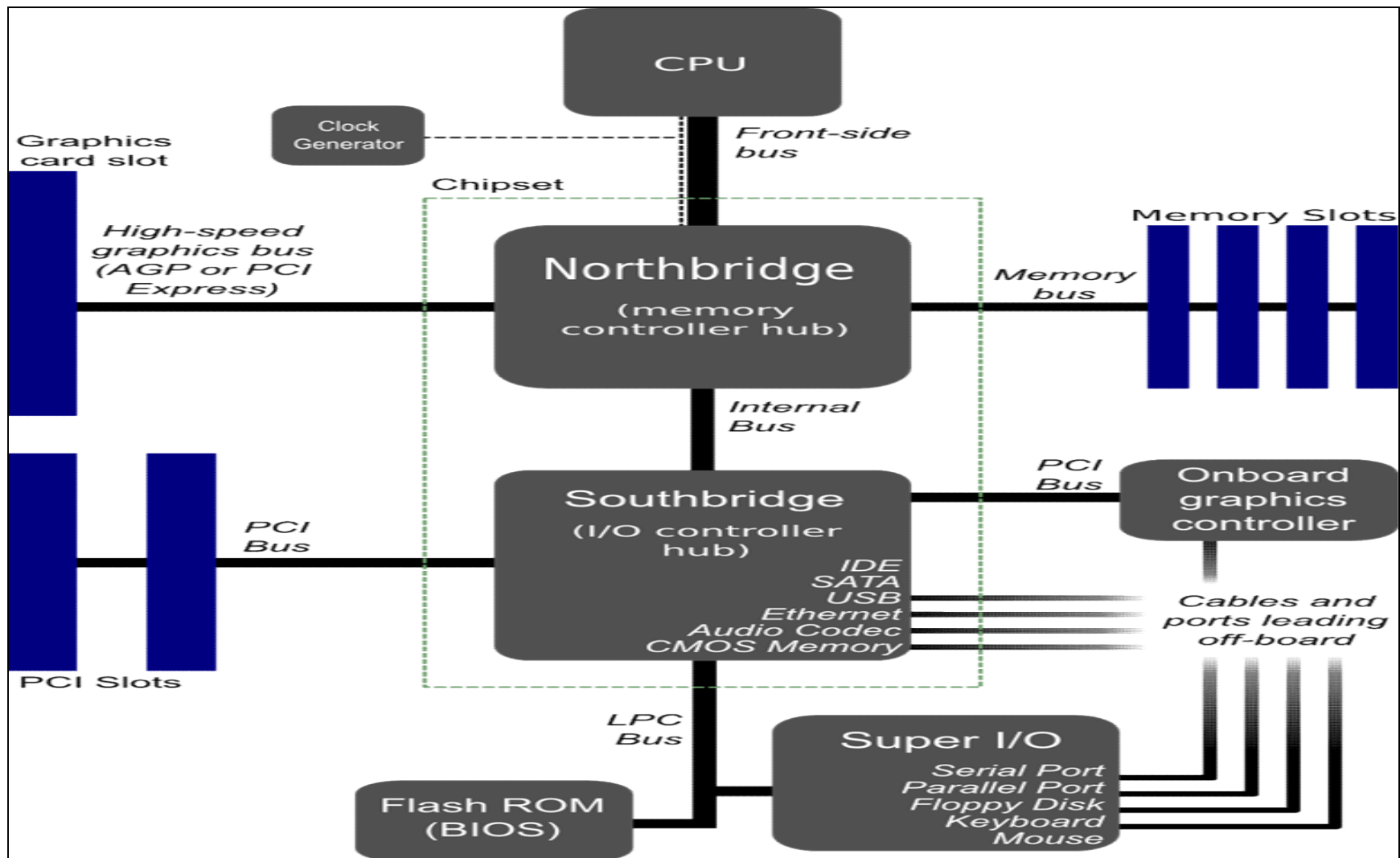
# I/O Processor on Motherboards

## Real Picture



# I/O Processor on Motherboards Block Diagram

(not required in the exam)



# Input devices

The devices which are used to give input from the external world to the computer system are known as input devices. The most widely used and popular input devices in the world of computers are:

- Keyboard and Mouse
- Touch Screen
- Scanner
- Webcam
- IP Camera
- Microphones and Headphones (Separate Lecture)



# Keyboard and Mouse

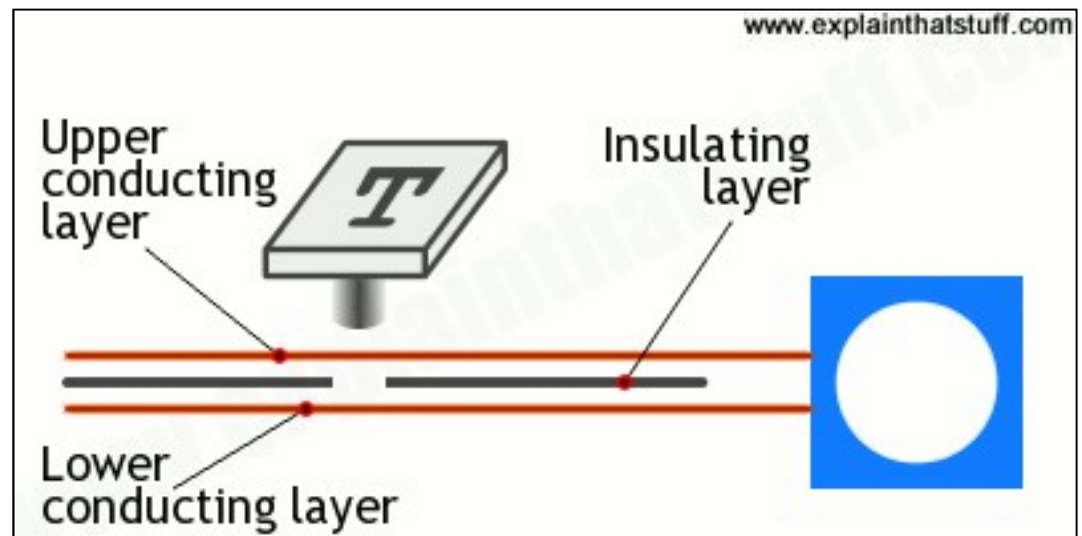
A **keyboard** is one of the essential informative device used to give inputs to the computer system. Like an electric typewriter, it is made of keys/buttons that make letters, numbers, and icons/symbols to perform different functions.

A **mouse** is one of the most popular input devices which is also known as a pointing device. It controls a computer screen's cursor or pointer in such a manner in which it proceeds. Its name originates from its structure similarity like corded and curved formed with the mouse that seems as though a mouse tail.



# How Keyboard Works?

There are three separate layers of plastic that work together to detect the key presses. Two of them are covered in electrically conducting metal tracks and there's an insulating layer between them with holes in it. The dots are places where the keys press the two conducting layers together. The lines are electrical connections that allow tiny electric currents to flow when the layers are pressed tight to one another by a key moving down from above.



# Types of Keyboard

## Types of Keyboard

- **Standard External Keyboard**
- **Integrated laptop keyboard:** the keys are set with a short distance, and number of keys are limited doesn't have a numeric keypad
- **Virtual keyboard:** available with touch screens.



# Types of Mouse

**Mechanical Mouse**: includes a metal or rubber ball in its underside. When the ball roll mouse pointer moves accordingly, and sensors inside the mouse recognize the movement of the ball and subsequently impart signs to the cursor on the screen.



**Optical mouse**: produces light from a LED or laser and a light sensor which identifies the reflections as the mouse is moved. It is better than mechanical mouse since its fixed base surface do not absorb dirt and dust.



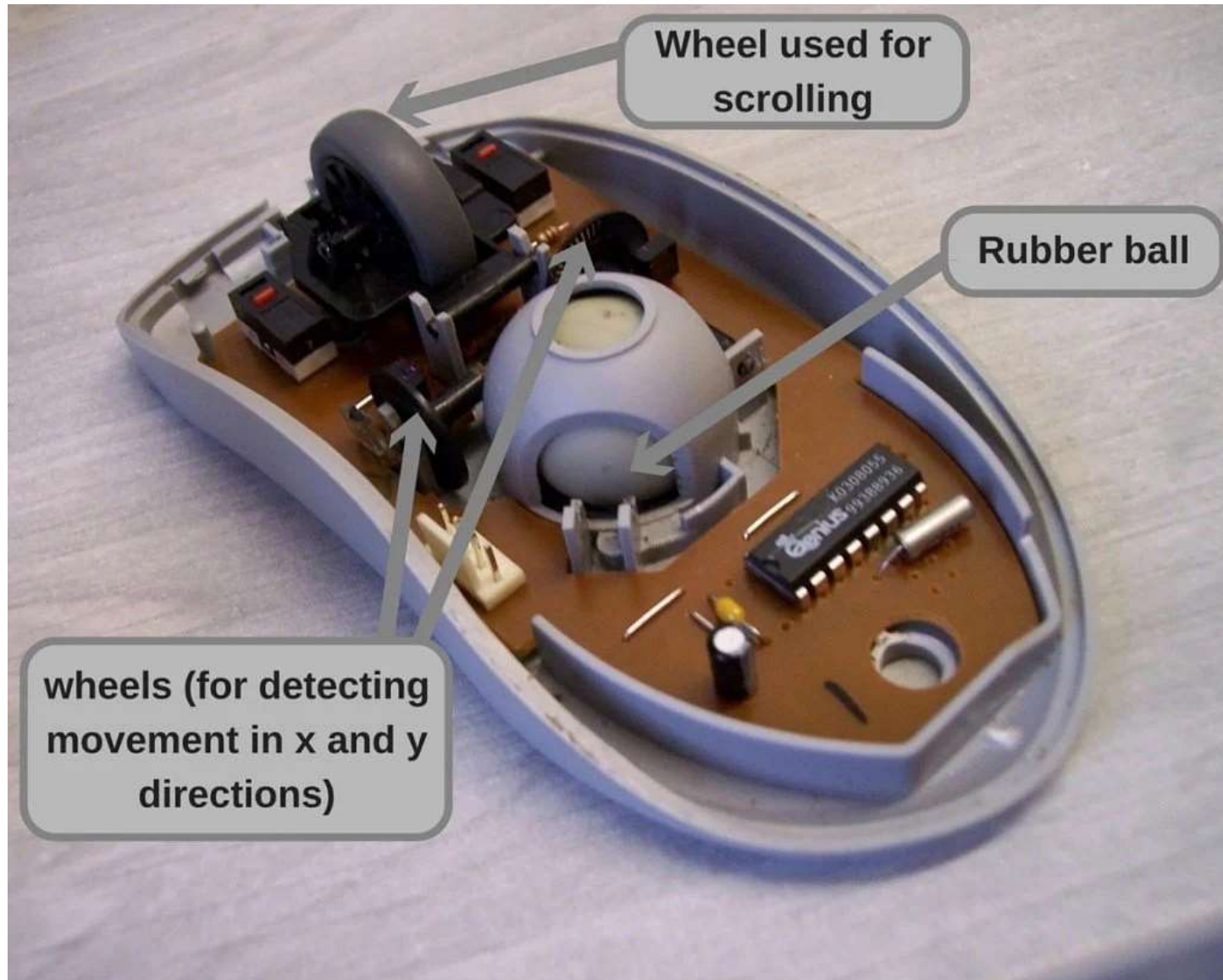
**Trackball mouse**: has a moveable ball on the top, which can be moved in any direction rather than moving the entire device.



**Touchpad**: is an input device on laptops and some keyboards. It allows the user to move a cursor with their finger. It can be used in place of an external mouse.



# How Mechanical Mouse Works?

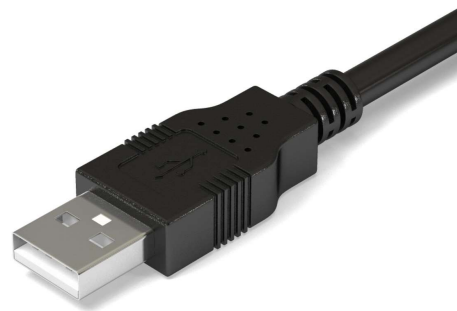




# Keyboard and Mouse Interfaces

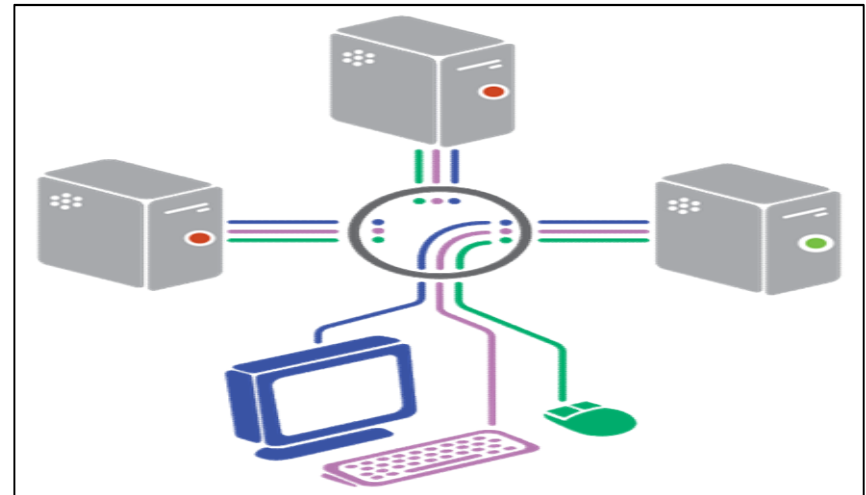
## Types of Interfaces

- **PS/2 Interface:** it was introduced with the IBM PS/2 series in 1986, and is now used by all ATX and ATX-variant motherboards. PS/2 keyboards use the 6-pin mini-DIN connector
- **USB Wired Interface**
- **USB Wireless Interface:** with wireless USB connector



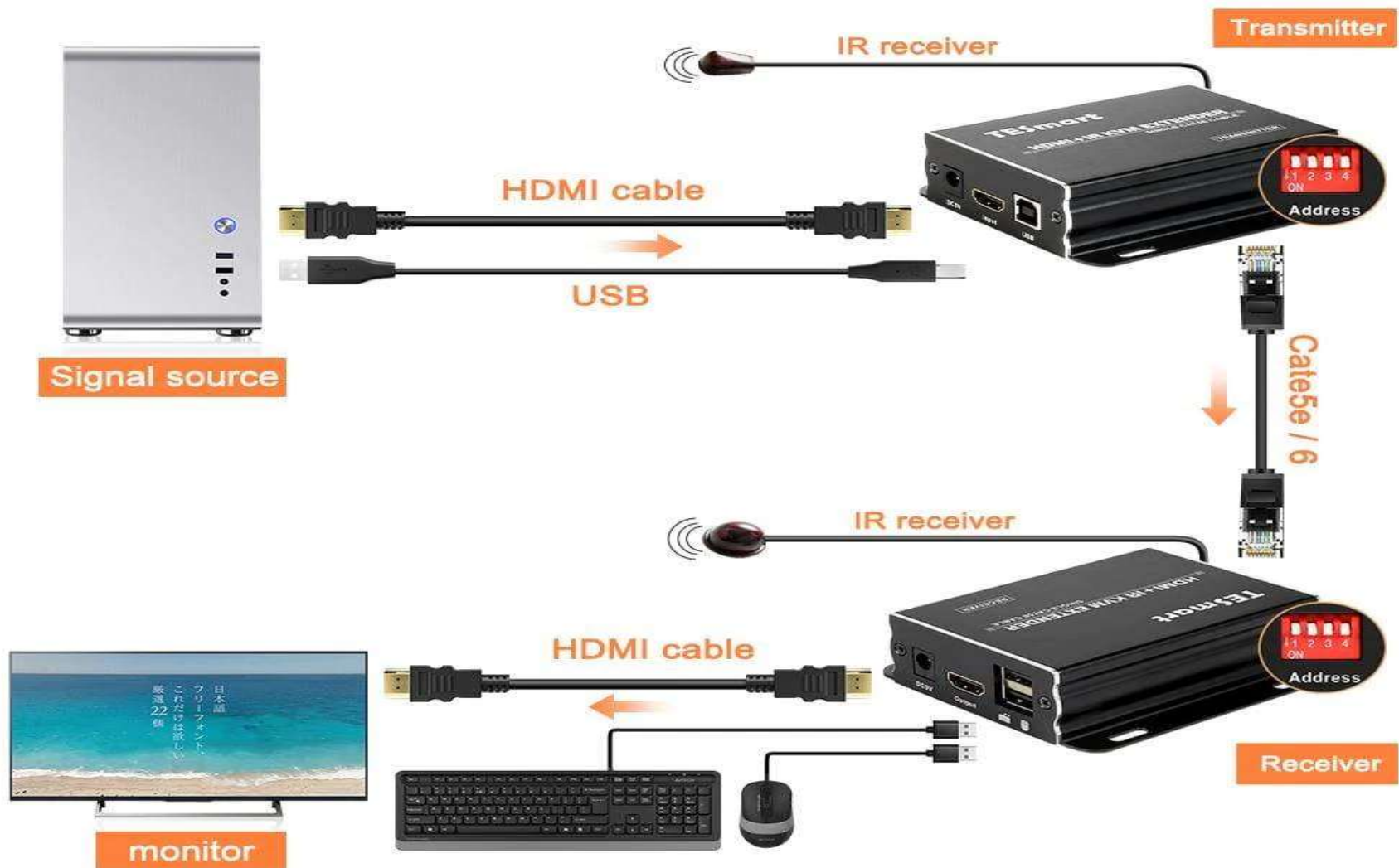
# KVM Switch and KVM Extender

**KVM switch** (with KVM being an abbreviation for "keyboard, video and mouse") is a hardware device that allows a single user to control multiple computers from one set of keyboard, monitor, and mouse.



**KVM extender** is a device designed to increase the distance between a keyboard, monitor and mouse (KVM station) and a computer. From 5-10 m to 150 m using Ethernet cable or even remote sites via IP connections. The main purpose of KVM extenders is to provide point-to-point computer extension and scale the access to computers from remote locations.

## HDMI KVM extender 1 transmitter to 1 receiver





# Touch Screen

A touch screen is a display device that allows the user to interact with a computer using their finger or stylus. They're a useful alternative to a mouse or keyboard for navigating a GUI (graphical user interface).

Touch screens are used on a variety of devices, such as a computer and laptop displays, smartphones, tablets, and ATM.



## Touch Screen Technologies

1. **Capacitive** — It is the most popular technology. It has a grid of capacitors. When a finger or conductive stylus is close to the surface, the grid sees a change in capacitance at a specific location on the screen.
2. **Resistive** — It is the oldest technology. It has a grid of tiny switches, which can detect the press of a finger or stylus at a specific location on the screen.
3. **Optical** — It has optical sensors on the screen that detects the shadow of a finger or stylus at a specific location on the screen

# Scanner

- A scanner is an input device that converts paper documents or pictures into the form of a computerized document as an image or PDF.

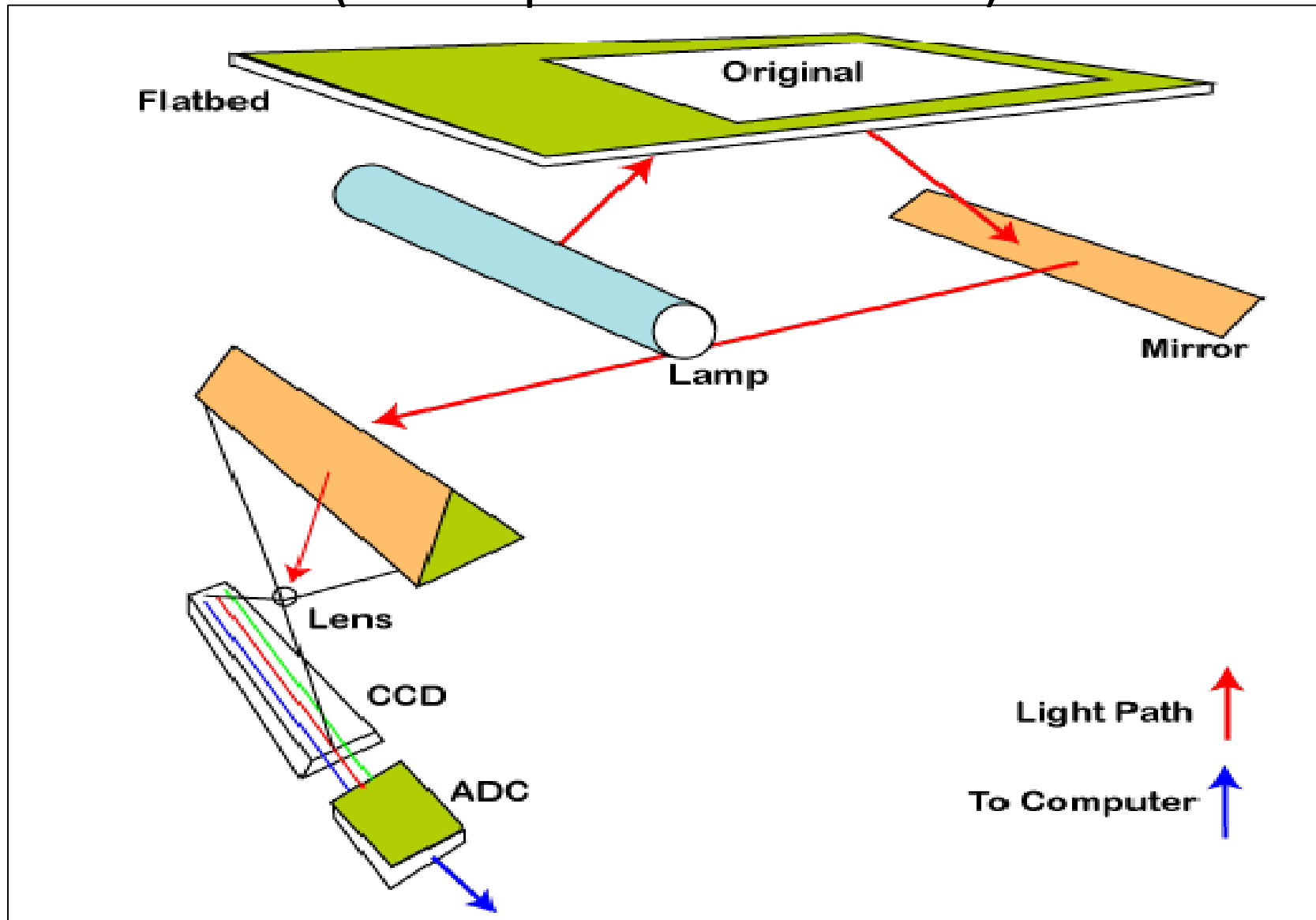


## How Scanner works?

- Scanners operate by shining light at the object or document being digitized and directing the reflected light (usually through a series of mirrors and lenses) onto a photosensitive element. In most scanners, the sensing medium is an electronic, light-sensing integrated circuit known as a **charged coupled device (CCD)**, which converts the levels of brightness into electronic signals that are then processed into a digital image.

# Scanner

(not required in the exam)



# Webcam

Webcam is a video camera that faces the user. Webcams are built into laptops but are separate units that attach to the monitor of a desktop computer. A Webcam is used for video calling and taking selfies, and most models include a microphone.

Desktop camera



Laptop camera



# IP Camera

IP cameras (also called network cameras, IP CCTV cameras, IP webcams, Internet cameras or IP security cameras) allow to access live or recorded video from any PC connected to the computer network or the Internet. For example, the IP security cameras could be located in shop branches in Erbil, and Shaqlawa and a remote user can view them all via a single PC connected to Internet.

The IP Cameras can be classified in terms of different features:

- fixed or rotating (PTZ).
- indoor or outdoor.
- wired or wireless
- Day only or Day and Night (Infrared).
- Video Quality (HD, Full HD, Ultra HD, 2K, 4K)



Fixed



PTZ



Outdoor

# Output devices

The devices which are used to send output from the computer to the external world. The most widely used and popular output devices in the world of computers are:

- Monitor and Projector (Separate Lecture)
- Speakers and Headphone (Separate Lecture)
- Printer

# Printer

A printer is an external hardware output device that takes the electronic data stored on a computer or other device and generates a hard copy. Network Printer can be accessed remotely across the network.

## Types of Printers:

- **Dot matrix printers:** use print heads to shoot ink or strike an ink ribbon to place hundreds to thousands of little dots to form text and images. It is an old technology but used to print bills in retail shops and government offices.
- **Inkjet printers:** The most popular printer for home users that prints by spraying streams of quick-drying ink on paper.
- **Laser printers:** They work by using a heated wire to positively charge a drum, which is then passed over by a laser that reverses the charge in the areas that it hits. Laser printers are often used for corporate, school, and other environments that require print jobs to be completed quickly and in large quantities.

# Types of Printers

## Dot Matrix Printer



## Inkjet Printer



## Laser Printer





# Typical I/O Device Data Rates

