

USB (UNIVERSAL SERIAL BUS)

Universal Serial Bus, USB is a plug and play interface that allows a computer to communicate with peripheral and other devices. USB-connected devices cover a broad range; anything from keyboards and mice, to music players and flash drives. The USB has been designed to meet several key objectives

- Provide a simple, low-cost, and easy to use interconnection system that overcomes the difficulties due to the limited number of I/O ports available on a computer
- Accommodate a wide range of data transfer characteristics for I/O devices, including telephone and Internet connections
- Enhance user convenience through a “plug-and-play” mode of operation

USB devices

Today, there are millions of different USB devices that can be connected to your computer. The list below contains just a few of the most common.

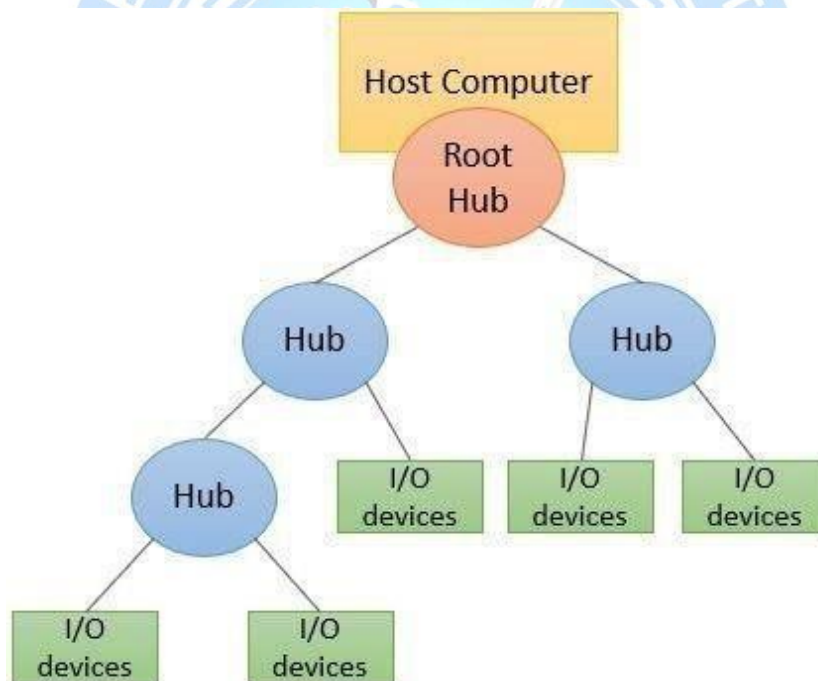
- Digital Camera
- External drive
- iPod or other MP3 players
- Keyboard
- Keypad
- Microphone
- Mouse
- Printer
- Joystick
- Scanner
- Smartphone
- Tablet
- Webcams

USB

Architecture

When multiple I/O devices are connected to the computer through USB they all are organized in a tree structure. Each I/O device makes a *point-to-point* connection and transfers data using the *serial transmission format* we have discussed serial transmission in our previous content 'interface circuit'.

As we know a tree structure has a **root**, **nodes** and **leaves**. The tree structure connecting I/O devices to the computer using USB has nodes which are also referred to as a **hub**. Hub is the intermediary connecting point between the I/O devices and the computer. Every tree has a root here, it is referred to as the **root hub** which connects the entire tree to the hosting computer. The leaves of the tree here are nothing but the I/O devices such as a mouse, keyboard, camera, speaker.



Universal Serial Bus Tree Structure

USB Protocols

All information transferred over the USB is organized in packets, where a packet consists of one or more bytes of information

- The information transferred on the USB can be divided into two broad categories: control and data
- Control packets perform such tasks as addressing a device to initiate data transfer, acknowledging that data have been received correctly, or indicating an error
- Data packets carry information that is delivered to a device. For example, input and output data are transferred inside data packets

USB Device States

A USB device can have several possible states as described below:

- **Attached State:** This state occurs when the device is attached to the Host.
- **Powered State:** After the device is attached, the Host provides power to the device if it does not have its own power supply. The device should not draw more than 100 mA in this state.
- **Default State:** This state occurs when the device is reset and has not been assigned a unique address. In this state the device uses default control pipe for communication and default address 0.
- **Addressed State:** The USB device enters this state after it gets a unique address which is used for future communications.
- **Configured:** When the Host obtains required information from the device, it loads the appropriate driver for the device. The host configures the device by selecting a configuration. The device is now ready to do the operations it was meant for.
- **Suspended State:** The USB device enters the suspended state when the bus remains idle for more than 3mS. In this state, the device must not draw more than 500uA of current.