**Input Output Devices**

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## Hard Disks

Hard disks store changing digital information in a relatively permanent form. They allow the computer to remember information when the power goes out.

A hard disk is a sealed aluminium box with controller electronics attached to one side. The electronics control the read/write mechanism and the motor that spins the platters. The electronics also assemble the magnetic domains into bytes (reading), and turn bytes into magnetic domains (writing). The electronics are all contained on a small board that detaches from the rest of the drive.

Underneath the board, are connections for the motor that spins the platter, and a highly filtered vent hole that lets internal and external pressures equalize.

Inside the drive, there are platters that are manufactured to amazing tolerances and are mirror smooth. They spin extremely fast. Most hard disks have multiple platters to store more information. There is also the arm that holds the read/write heads. The arm is able to move the heads from the hub to the edge of the drive. The arm and its movement mechanism are extremely light and fast. The arm can move from the hub to the edge and back up to 50 times per second. The mechanisms to move the arm can be constructed using a high-speed linear motor.

Hard disks use a magnetic recording technique. They have a magnetic medium, held by a hard platter. The magnetic medium can be easily erased and rewritten, and it will remember the magnetic flux patterns stored onto the medium for a very long time.

Data is stored on the surface of the platter in sectors and tracks. Tracks are concentric circles, and sectors are pie-shaped wedges on the tracks. A sector has a fixed number of bytes. Sectors are often grouped together into clusters. Low-level formatting a drive establishes the tracks and sectors on the platter. The start and end points of each sector are written onto the platter. This prepares the drive to hold blocks of bytes. High-level formatting writes the file storage structures, like the file allocation table, into the sectors. This prepares the drive to hold files.

Hard disks typically have a capacity of 10 – 40 GB. They store data in the form of files, which is just a named collection of bytes. When a program requests a file, the hard disk retrieves the bytes and sends them to the CPU one at a time.

The two major parameters to measure a hard disk’s performance is to measure its data rate and seek time. The data rate is the number of bytes per second the hard disk can deliver to the CPU. Common rates are between 5 to 40 MB per second. The seek time is the time between when the CPU requests a file and when the first byte of the file is sent to the CPU. Commonly, the time is between 10 to 20 milliseconds.

Difference between Cassette Tape and Hard Disk:

* The magnetic recording material on a cassette tape is coated onto a thin plastic strip. In a hard disk, it is layered onto high-precision aluminium or glass. The hard disk platter is then polished to mirror-type smoothness.
* A tape must be fast-forwarded or reversed to reach a particular point, which can become a very lengthy process. On a hard disk, any point on the surface of the disk can be reached almost instantly.
* In a cassette, the read/write head touches the tape directly. In a hard disk, it ‘flies’ over the disk, never touching it.
* The tape in a cassette tape moves over the head at about 2 inches per second. The hard disk platter can spin under its head at up to 3000 inches per second.
* The information on a hard disk is stored in extremely small magnetic domains compared to those of a cassette tape. The size of these domains is possible due to the precision of the platter and the speed of the medium.

Thus, a modern hard disk is able to store an amazing amount of data in a small space, and access that information in a fraction of a second.

## Solid State Drives

They have lower power-consumption, are lighter, have quicker access time and have higher read speeds. They are however, much more expensive.

## Optical Disk Drive

An optical drive is a type of computer disk drive that reads and writes data from optical disks through laser beaming technology.

This type of drive allows a user to retrieve, edit and delete the content from optical disks such as CDs, DVDs and Blu-ray disks. Optical drives are among the most common computer components.

An optical drive may also be known as an optical disk drive (ODD).

Although an optical drive can be used to read and write, it is mainly used as an input device. The functionality of an optical drive is dependent on optical disks. In other words, an optical drive is of no use without an optical disk inserted into it.

Optical drives work by rotating the inserted disk at a constant speed, calculated in revolutions per minute (RPM), which generally range from 1,600- 4,000 RPM, where speeds provide faster data reading time. The rotating disk in an optical drive is read with a laser beam propagated using the lens embedded within the optical drive’s head. Optical drives mainly use an Advanced Technology Attachment (ATA) bus or a Serial ATA bus, along with Small Computer System Interface (SCSI) to send and receive data from the computer.

## Blu-Ray Disk

A Blu-ray disk (BD) is a high-capacity optical disk medium developed for recording, rewriting and playing back high-definition video. It can store large amounts of data and was designed to supersede the DVD.

Blu-ray was jointly developed by a group of personal computer and consumer electronics companies called the Blu-ray Disc Association. Blu-ray disks support higher resolutions and more advanced video and audio formats compared to DVDs.

Blu-ray technology gets its name from the blue-violet laser that is used to read Blu-ray disks. Compared to a DVD’s red laser, a blue laser permits more information to be stored at a greater density. For example, while a DVD can store 15 GB per layer, a Blu-ray disk can store 25 GB per layer, and dual-layer disks can hold up to 50 GB.

Compared to a DVD, Blu-ray also provides much higher resolution; while a DVD with standard definition can provide definition of 720x480 pixels, Blu-ray high definition has 1920X1080 pixel resolution.

## Inkjet Printers

Inkjet printers place extremely small droplets of ink onto paper to create an image. It has the following parts:

* A stepper motor controls the movement of most parts of the inkjet printer.
* A stabilizer bar and belt are used to ensure movement is precise and controlled.
* A roller moves paper through the printer.
* The print head assembly contains a series of nozzles that are used to spray drops of ink.
* The mechanical operation of the printer is controlled by a small circuit board containing a microprocessor and memory.
* A typical colour ink cartridge has cyan, magenta and yellow inks in separate reservoirs.

## Laser Printers

Laser printers essentially use static electricity as a temporary glue.

## Mice

A mouse translates the motion of the user’s hand into signals that the computer can use.

### Track-ball Mouse

A ball inside the mouse touches the desktop and rolls when the mouse moves. Two rollers inside the mouse touch the ball. One is oriented to detect motion in the x direction, and the other is oriented to detect motion in the y direction. The rollers connect to a shaft that spins a disk with holes in it. When a roller rolls, the shaft and disk spin. On either side of the disk there is an infrared LED and an infrared sensor. The holes in the disk break the beam of light from the LED so the sensor sees pulses of light. The rate of pulsing is directly related to the speed of the mouse and the distance it travels. The two LEDs on either side of the disk are arranged in such a way so that if one is clearly the visible, the other is partially hidden. Every time the second LED is hidden, if the first LED becomes visible, movement is in one direction, and if the first LED becomes hidden, the movement is in the other direction. An on-board processor chip reads the pulses from the sensors and turns them into binary data that the computer understands.

### Optical Mice

A red LED bounces light off of a surface onto a CMOS (Computer Metal Oxide Semiconductor) sensor. A CMOS sensor is an electrical chip that converts photos to electrons for digital processing. The CMOS sends each signal to the DSP (Digital Signal Processor). The DSP detects patterns in the images and examines how the patters change. Based on the change in patterns, the DSP determines which direction to move the cursor and how far, and sends this information to the computer.

Optical mice are better than track-ball mice since they have no moving parts, so there is no wear and tear, dirt can’t get inside the mouse and interfere with the sensors, it has a higher tracking resolution so response is smoother, and they don’t require a special surface like a mouse pad.

The accuracy of optical mice depends on their resolution. The higher the resolution, the more sensitive the mouse is. Typical mice have a resolution of 400 or 800 dpi, while gaming mice have resolutions up to 1600 dpi.

Factors that affect the quality of the mouse are, size of the optical sensor, refresh rate, image processing rate and maximum speed.

### Wireless Mice

Wireless mice use radio waves to communicate the motion of the mouse with the computer. Radio waves are beneficial since they do not need a clear line of sight with the receiver (unlike infra-red), the require low power and can thus run on batteries and the components are cheap and light weight.

## Keyboards

Keyboards use switches and circuits to translate the user’s keystrokes into signals the computer can understand. The keyboard can be used to type, play games, use shortcuts and more. The keys, called keycaps, are usually the same shape and size and placed in the same pattern in nearly all keyboards. Keyboards include typing keys, a numeric keypad, function keys and control keys.

The typing keys are the letters of the alphabet, generally laid out in the same pattern as typewriters. This layout is called QWERTY, for the first 6 letters in the top row. The numeric keypad contains 17 keys in the same configuration as in most calculators.

A keyboard has its own processor and circuitry. It contains the key matrix, which is a grid of circuits underneath the keys. When a key is pressed, a switch completes the circuit beneath it allowing a tiny current to flow through. The location of the completed circuit is compared with a character map inside the ROM of the keyboard. From this, the processor can tell which keys are being pressed.

Mechanical keyboards have 4 types of switches, rubber dome, membrane, metal contact and foam element.

Rubber dome switches are most common. When a key is pressed, a plunger on the bottom of the key presses against a rubber dome with a carbon centre. The carbon centre presses against the hard surface of the key matrix below, completing the circuit. When the key is released, the rubber dome pushes the key back up. Metal contact and foam element keyboards essentially just press down the switch to complete the circuit. This means they are more susceptible to wear and tear.

Wireless keyboards use radio waves to send information to the computer.

## Display Devices

### Segmented Displays

Segmented displays only show digits or alphanumeric characters. They are composed of several segments that switch on and off to give appearance of a desired glyph. The segments are usually single LEDS. They are mostly used in digital clocks or calculators.

### LED Displays

An LED display is a flat panel display that uses an array of light-emitting diodes as pixels for video display. They are bright enough to be used outdoors. They have almost completely replaced CRT monitors due to their smaller size and better quality.

### Liquid Crystal Displays

A liquid-crystal display is a flat-panel display that uses the light-modulating properties of liquid crystals. Liquid crystals do not produce light directly, but use a backlight to produce images in colour or monochrome. LCDs are used in a wide range of applications, including televisions, computer monitors, instrument panels and electronic signage. Small LCD screens are common in portable devices like watches, cameras, calculators and even smart phones. They are a replacement for CRT displays since they are much smaller and can be used on a range of screen sizes and are more energy efficient.