Rajmani Kumar,
Lecturer, Dept. of BCA
S.U.College, Hilsa (Nalanda)
Patliputra University, Patna

BCA-1st Year **Paper-I**

External Storage Devices

A storage device is used in the computers to store the data. Provides one of the core functions of the modern computer. Most desktop micro computer systems have floppy disks, hard disks, and optical disk drives. Are used to save, back up, and transport data files and programs.

Two major types of secondary storage devices:

Sequential Access Storage Devices (SASD)

- Arrival at the desired storage location may proceeded by sequencing through other location.
- Data can only be retrieved in the same sequence in which it is stored.
- Access time varies according to the storage location of the information being accessed.
- Suitable for sequential processing applications where most, if not all, of the data records need to be processed one after another.
- Magnetic tape is a typical example of such s storage device.

Sequential Access Storage Devices

- Data is stored and retrieved sequentially
- Must be accessed in sequence by searching through prior data
- Magnetic tape
- Serial Devices Magnetic tapes (very fast sequential access)

Direct Access Storage Devices (DASDs) or Random Access Memories (RAM)

- Device where any storage location may be selected and accessed at random.

- Permits access to individual information in a more direct or immediate manner.
- Approximately equal access time is required for accessing information from any storage location.
- Suitable for direct processing applications such as online ticket booking systems.
- Magnetic, optical and magneto-optical disks are typical examples of such a storage device.

Direct Access Storage Devices (DASDs)

- Directly store and retrieve data
- Each storage position has a unique address and can be accessed in the same length of time (index)
- Semiconductor memory chips, magnetic disks
- Magnetic Discs Hard disks (high capacity, low cost, fast)
- Floppy disks (low capacity, lower cost, slow)
- Optical Disks CD-ROM = (Compact disc, read-only memory)

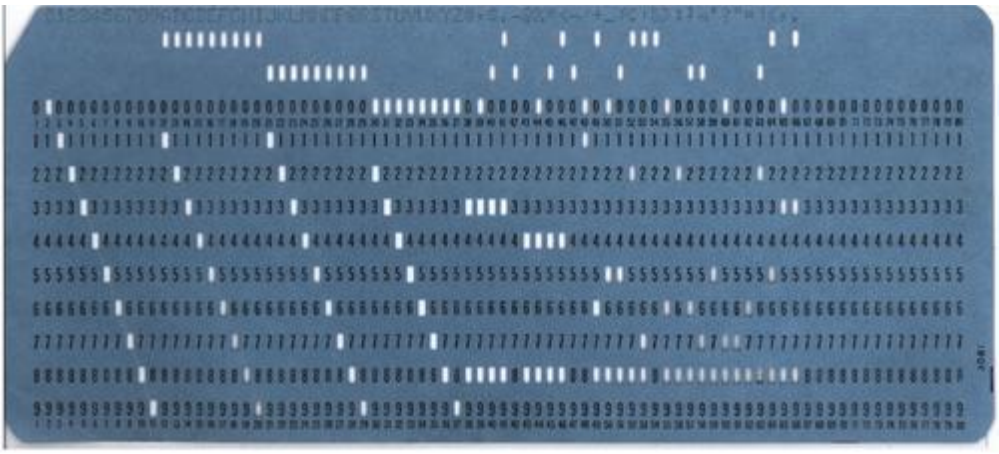
Punch Card

Punch cards (or "punched cards"), also known as **Hollerith cards** or **IBM cards**, are paper cards in which holes may be punched by hand or machine to represent computer data and instructions. They were a widely-used means of inputting data into early computers. The cards were fed into a card reader connected to a computer, which converted the sequence of holes to digital information.

For example, an early computer programmer would write a program by hand, then convert the program to a series of punched cards using a punch card machine. The programmer would then take the stack of cards to a computer, and feed the cards into a card reader to input the program. Pictured is an example of a woman using a punch card machine to create a punch card.

- Early method of data storage used with early computers

- Punch cards also known as Hollerith cards
- Containing several punched holes that represents data



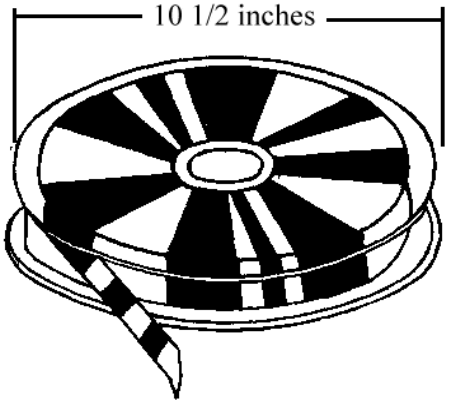
Punch Card

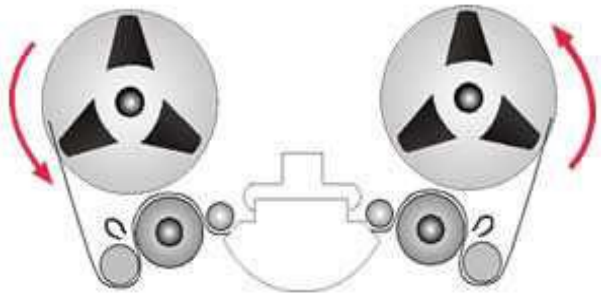
Magnetic Tapes

Magnetic tape is a narrow plastic ribbon coated with an easily magnetisable material on which data can be recorded. It is used in sound recording, audiovisual systems (videotape), and backups.

Tape is still used to make backup copies of important data. Information is recorded on the tape in binary form, with two different strengths of signal representing 1 and 0.

The device that reads the tape is the **Tape Drive** or **Tape Unit**.





Magnetic tape comes mainly in two different forms:

Reel to Reel - Large reels of tape which must be loaded into a reel-to-reel tape drive. This type of tape is usually used by mainframe computers.

Cartridges- The tape is supplied in a small cartridge rather like a music tape. This type of tape is used on PCs (microcomputers) and the device used to read/write the tapes is called a **tape streamer**. Capacities of cartridges vary from 10Gb to 200Gb.

- A magnetically coated strip of plastic on which data can been coded.

- Tapes for computer sare similar to tapes used to store music.
- Tape is much less expensive than other storage mediums but commonly a much lower solution that is commonly used for backup.

External/Internal Fragmentation

External fragmentation can be represented by a highly fragmented disk storage with many small empty holes..

Internal fragmentation: loss of space within a sector or a cluster.

Due to records not fitting exactly in a sector:

e.g. Sector size is 512 and record size is 300 bytes. Either

store one record per sector, or

allow records *span* sectors.

Due to the use of clusters: If the file size is not a multiple of the cluster size, then the last cluster will be partially used.

Blocking utilization factor,

- Disk tracks may be divided into user-defined blocks rather than into sectors.
- Blocks can be fixed or variable length.
- A block is usually organized to hold an integral number of logical records.

Blocking Factor = number of records stored in a block.

. No internal fragmentation, no record spanning over two blocks.

. In block-addressing scheme each block of data may be accompanied by one or more *subblocks* containing extra information about the block: record count, last record key on the block.

Non-data Overhead

- Both blocks and sectors require non-data overhead(written during formatting)
- On sector addressable disks, this information involves sector address, track address, and condition (usable/defective). Also pre-formatting involves placing gaps and synchronization marks between the sectors.
- Where a block may be of any size, more information is needed and the programmer should be aware of some of this information to utilize it for better efficiency.

Magnetic Discs

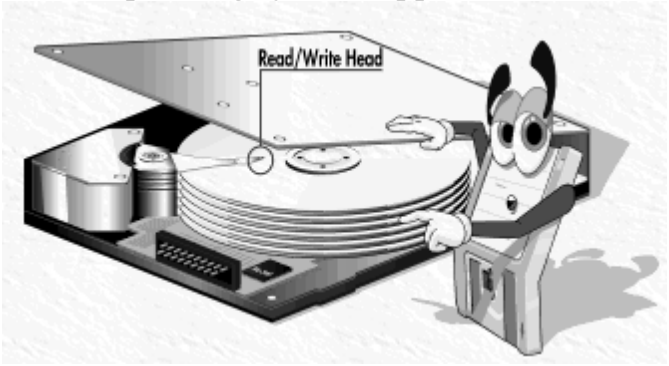
Bits of data (0.s and 1.s) are stored on circular magnetic platters called disks.

- A disk rotates rapidly (& never stops).
- A disk head reads and writes bits of data as they pass under the head.

- Often, several platters are organized into a disk pack (or disk drive).

Hard Disks

The hard disk is a magnetic disk, usually fixed in the drive (internal) although nowadays there also exist external hard disks. Access to data is far faster than access to floppy disks. Hard disks store far more data than floppy disks. They are more reliable then floppy disks - there is better protection against dirt. Hard disks are used to store the operating system, application software and users' files.



A hard disk is made of a rigid disk which is coated with a magnetisable material. Hard disks spin much more quickly than floppy disks and the disk **read/write head** is positioned very close to the disk (thousandths of a millimeter away). Because the disk head is positioned so close to the disk hard drives can easily be damaged by dust or vibration. Therefore the disk, the drive head and all the electronics needed to operate the drive are built together into a sealed unit. This picture shows a hard disk drive with the case removed.

Usually (as in the picture above) several physical disks are contained in one harddisk unit. Each disk is known as a **platter**. Typical hard disk capacities for a home PC now start at up to 180 Gb.

Floppy Disks

Consists of a plastic case that measures 3 1/2 by 5 inches. Inside that case is a very thin piece of plastic (see picture at right) that is coated with microscopic iron particles (magnetic). This disk is much like the tape inside a video or audio cassette. Never touch the inner disk - you could damage the data that is stored on it.

Floppy disks are the smallest type of storage, holding only 1.44MB.

inside view

back view

Access to data is much slower than for hard disk. The data on the disk can be protected by sliding a small write-protect tab which prevents the contents of the disk from being changed.

Some hardware companies now produce storage devices (Zip disks) which are very similar to floppy disks but can store 100Mb or even 250Mb of data. These devices are also much faster than standard floppy disk drives.

How Hard disks and Floppy Disks Work - Magnetic

The process of reading and writing to a hard or floppy disk is done with electricity and magnetism. The surfaces of both types of disks can be easily magnetized. The electromagnetic head of the disk drive records information to the disk by creating a pattern of magnetized and non-magnetized areas on the disk's surface. Do you remember how the binary code uses *on* and *off* commands to represent information? On the disk, magnetized areas are *on* and non-magnetized

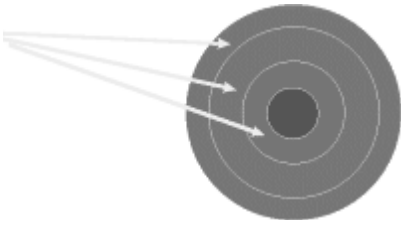
areas are *off*, so that all information is stored in binary code. This is how the electronic head can both write to or read from the disk surface.

It is very important to always keep magnets away from floppy disks and away from your computer! The magnets can erase information from the disks!

Format of Magnetic Disks

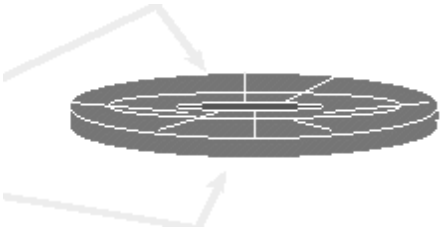
All magnetic disks are similarly **formatted**, or divided into areas, called Tracks and Sectors. The formatting process sets up a method of assigning addresses to the different areas. It also sets up an area for keeping the list of addresses. Without formatting there would be no way to know what data went with what.

Tracks - A track is a circular ring on one side of the disk. Each track has a number. The diagram shows 3 tracks.



Sectors - A disk sector is a wedge-shape piece of the disk. Each sector is numbered.

Double side - A typical magnetic disk has two surfaces or sides. Each surface holds data in circular tracks and each track is divided into equal sections called sectors. The track number and sector number are used as an address to find where data is on the disk. Data can be **both written to and read from** the disk. Magnetic disks are **direct access** i.e. any data item can be accessed without reading other data first.



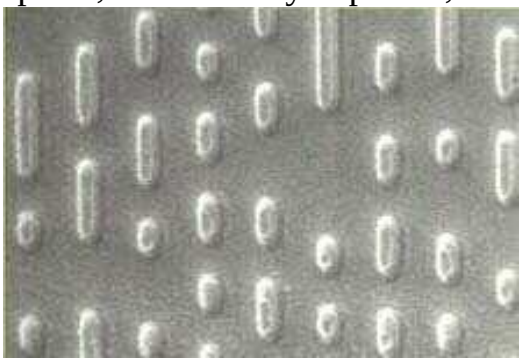
Optical Media

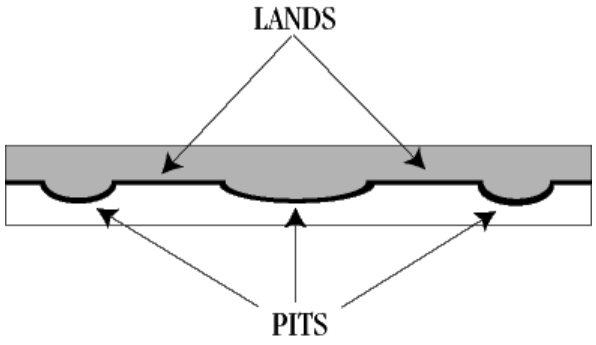
An optical disk is a storage medium in which laser technology is used to record and read large volumes of digital data.

Compact Disks

CDs use microscopic indentations and flat surfaces to store information much the same way floppies and hard disks use magnetic and nonmagnetic storage. Inside the CD-Rom is a laser that reflects light off of the surface of the disk to an electric eye.

Compact disks are exchangeable and easy to transport. Access to data is faster than access to floppy disks but slower than hard disks. CDs typically hold 650 or 700 megabytes of data, and are used in distributing large amounts of text and graphics, such as encyclopedias, catalogues, and technical manuals.





As with a hard disk the drive head in an optical drive can move directly to any file on the disk so optical disks are direct access.

CD-ROM (Compact Disk - Read Only Memory) - The data is written onto the CDROM disk before it is sold and can not be changed by the user. CD-ROMs are used for applications such as distributing software, digital videos or multimedia products.

CD-R (Compact Disk - Recordable) - A CD-R disk is blank when it is supplied. The user can write data to it just once. After data has been written to the disk it can not be changed. CD-Rs are often used for making permanent backups of data and distributing software when only a small number of copies are required.

CD-RW (Compact Disk - Rewriteable) - CD-RW disks can be read from and written to.

DVDs

DVD-ROM (Digital Versatile Disk - Read Only Memory) - DVD disks are able to store much more data than CD disks. The DVD standard includes disk capacities up to 30Gb. DVD-ROM disks can be read from but can not be written to.

DVD-RAM (Digital Versatile Disk - Random Access Memory) - DVD-RAM disks have all of the benefits of DVD-ROM disks and can be written to as well. These very high capacity disks are ideal for producing backups.

Because of their high capacity, DVD disks are used to store high quality video such as complete movies.

The Cost of a Disk Access

The time to access a sector in a track on a surface is divided into 3 components:

Time Component	Action
Seek Time	Time to move the read/write arm to the correct cylinder
Rotational delay (or latency)	Time it takes for the disk to rotate so that the desired sector is under the read/write head
Transfer time	Once the read/write head is positioned over the data, this is the time it takes for transferring data

Seek time

- Seek time is the time required to move the arm to the correct cylinder.
- Largest in cost.

Typically:

- 5 ms (miliseconds) to move from one track to the next (track-to-track)
- 50 ms maximum (from inside track to outside track)
- 30 ms average (from one **random** track to another **random** track)

Average Seek Time (*s*)-1

. It is usually impossible to know exactly how many tracks will be traversed in every seek,

- we usually try to determine the **average seek time** (***s***) required for a particular file operation.

. If the starting positions for each access are random, it turns out that the average seek traverses **one third of the total number of cylinders**.

- There are more ways to travel short distance than to travel long distance.

. Manufacturer.s specifications for disk drives often list this figure as the **average seek time** for the drives.

. Most hard disks today have ***s*** under 9 ms, and high-performance disks have ***s*** as low as 7.5 ms.

Average Seek Time (*s*)-2

. Seek time depends only on the speed with which the head rack moves, and the number of tracks that the head must move across to reach its target.

. Given the following (which are constant for a particular disk):

- Hs = the time for the I/ O head to start moving
- Ht = the time for the I/ O head to move from one track to the next

. Then the time for the head to move n tracks is:

. *Seek(n)= Hs+ Ht*n*

Rotational Latency(latency)-1

. Latency is the time needed for the disk to rotate so that the sector we want is under the **read/write** head.

. Hard disks usually rotate at about 5000-7000 rpm,

- 12-8 msec per revolution.
- Eg. for 7200 rpm, max latency is 8.33 msec.

Note:

-- Min latency = 0

-- Max latency = Time for one disk revolution

-- **Average latency (*r*)** = (min + max) / 2
= max / 2
= time for ½ disk revolution

Typically 6 . 4 ms, at average

Rotational Latency computation-2

- Given the following:

-- R = the rotational speed of the spindle, in number of rotations per second.

-- □_ = the number of radians through which the track must rotate; that is _/2_ in number of rotations.

-- then the rotational latency _ radians in msec is:

- Latency= ((_/2_)*/R)*1000, in ms*

Access time-1

. Transfer time is the time for the read/write head to pass over a block.

. The transfer time is given by the formula:

$$\text{Transfer time} = \frac{\text{number of sectors to transfer}}{\text{number of sectors per track}} \times \text{rotation time}$$

. e.g. if there are St sectors per track, the time to transfer one sector would be 1/ St of a revolution.

Access Time-2

. The transfer time depends only on the speed at which the spindle rotates, and the number of sectors that must be read.

. Given:

-- St = the total number of sectors per track.

-- the transfer time for n contiguous sectors on the same track is:

. Transfer Time =((*n/St)/R)*1000, in ms*

Numerical Problem

Exercise

Given the following disk:

- 20 surfaces
  800 tracks/surface
  25 sectors/track
  512 bytes/sector
- 3600 rpm (revolutions per minute)
  7 ms track-to-track seek time
  28 ms avg. seek time
  50 ms max seek time.

Find:

a) Disk capacity in bytes
b) Maximum and Average latencies
c) Total time to read the entire disk, one cylinder at a time

Exercise

Disk characteristics:

- Average seek time = 8 msec.
- Average rotational latency = 3 msec
- Maximum rotational latency = 6 msec.
- Spindle speed = 10,000 rpm
- Sectors per track = 25
- Sector size = 512 bytes

. **Q) What is the average time to read one sector? Read-write head is a-on the sector, b-off the sector.**

. **a) 6/25*1000=0.24 msec, b) 0.24+8**