COA

CH3-p4

Secondary Memory

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Secondary Storage Devices

- Secondary storage is a non - volatile memory (does not lose the data when the device is powered down) that it is not directly accessible by the CPU.

- It is used to store a large amount of data at lesser cost per byte than primary memory, it is less expensive than primary storage.

Types of Secondary storage devices

Types include:

- Hard disks.
- Floppy disks.
- CD ROMs.
- DVDs.
- Pen drives.

Secondary storage devices

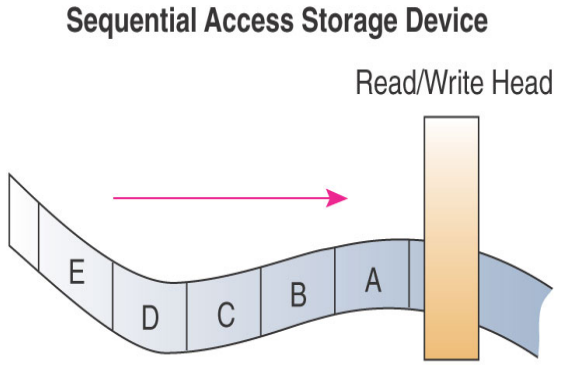
Two major types of storage devices:

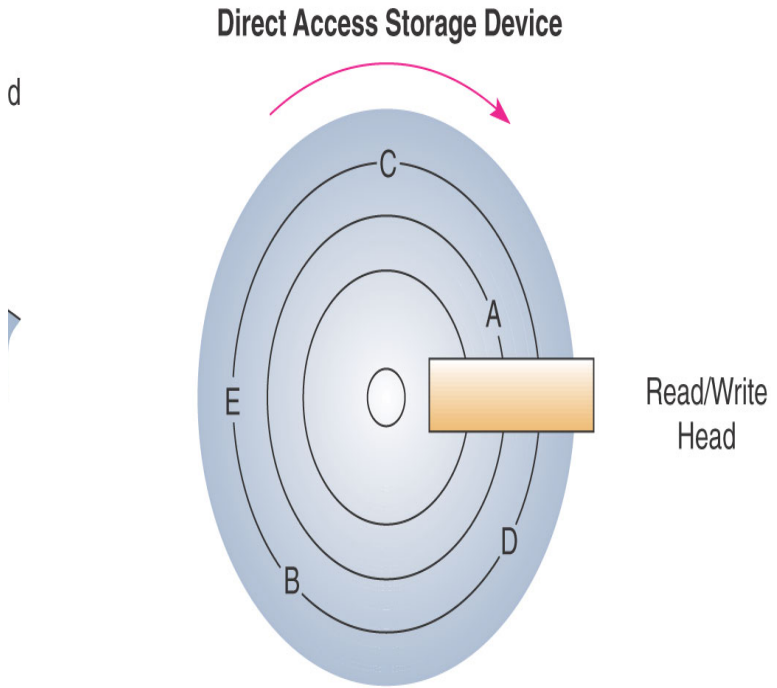
1. **Sequential access devices**

- **Magnetic tapes** (very fast sequential access)

2. **Direct Access Storage Devices (DASDs)**

- **Magnetic Disks**
  - Hard disks (high capacity, low cost per bit)
  - Floppy disks (low capacity, slow, cheap)
- Optical Disks
  - CD-ROM = (Compact disc, read-only memory)
- Memory Storage device
  - Flash drive
  - Memory card





:Magnetic Tape Storage

- Is a 1/4 inch or 1/2 inch ribbon(شريط) of plastic material on which data is recorded. It reads, writes and erases data on tapes.
- Magnetic tapes are reusable and made to store large quantities of data.

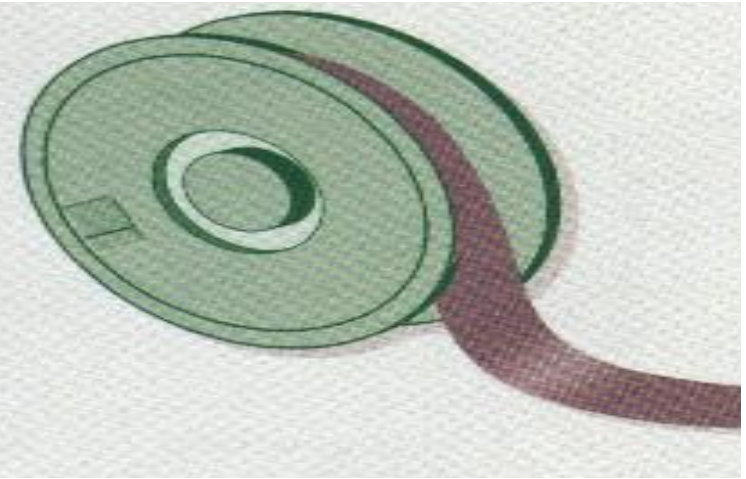
Magnetic Disk Storage:

- Magnetic disks are the most widely used storage medium for computers.
- It offers high storage capacity, reliability.

Magnetic tape

- **What is magnetic tape?**
  - **Thin layer of material capable of storing a magnetic signal**
    - **Usually contains Iron Oxide**

A **magnetic tape** is a continuous plastic strip wound onto a reel, quite similar to the tape used in reel-to-reel audio recorders. The magnetic tape's plastic base is treated with an **iron oxide** coating that can be **magnetized**.



Typically, the tape is one-half inch in width. It is wound in lengths from 400 to 3,200 feet.
(1 feet =12 inch)

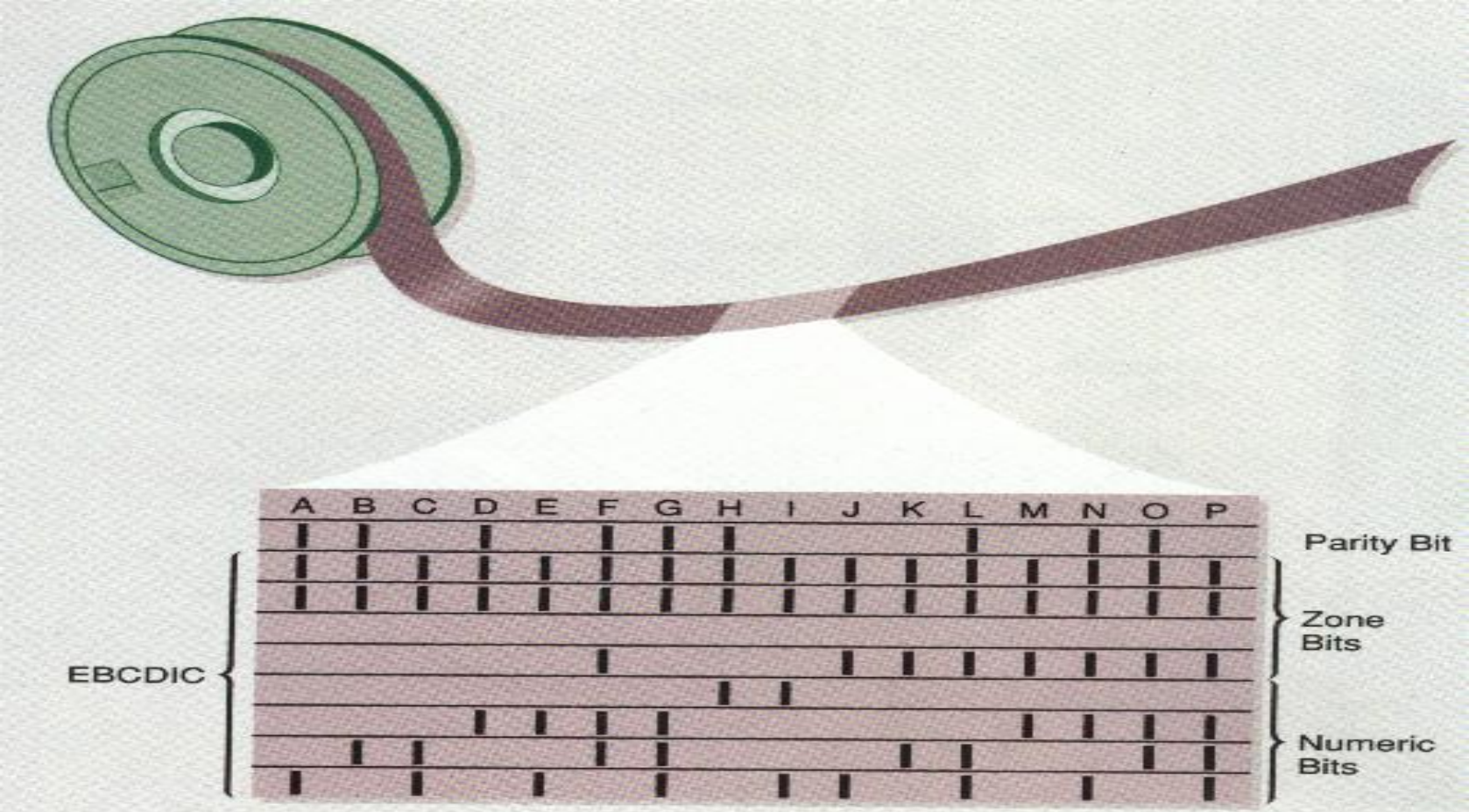
Some magnetic tapes are also packaged in plastic cartridges and cassettes for use with personal computers.

Data is stored on magnetic tape by magnetizing small spots of the iron oxide coating on the tape. Although these spots can be read (detected) by the computer, they are invisible to the human eye.

Large volumes of information can be stored on a single tape; densities of 1,600 characters per inch are common, and some tapes can store up to 6,250 characters per inch.

The most common method of representing data on magnetic tape uses a **nine-track coding scheme**, although other coding schemes are also used. When the nine-track method is used, the tape is divided into nine horizontal rows called **tracks** (see picture below).

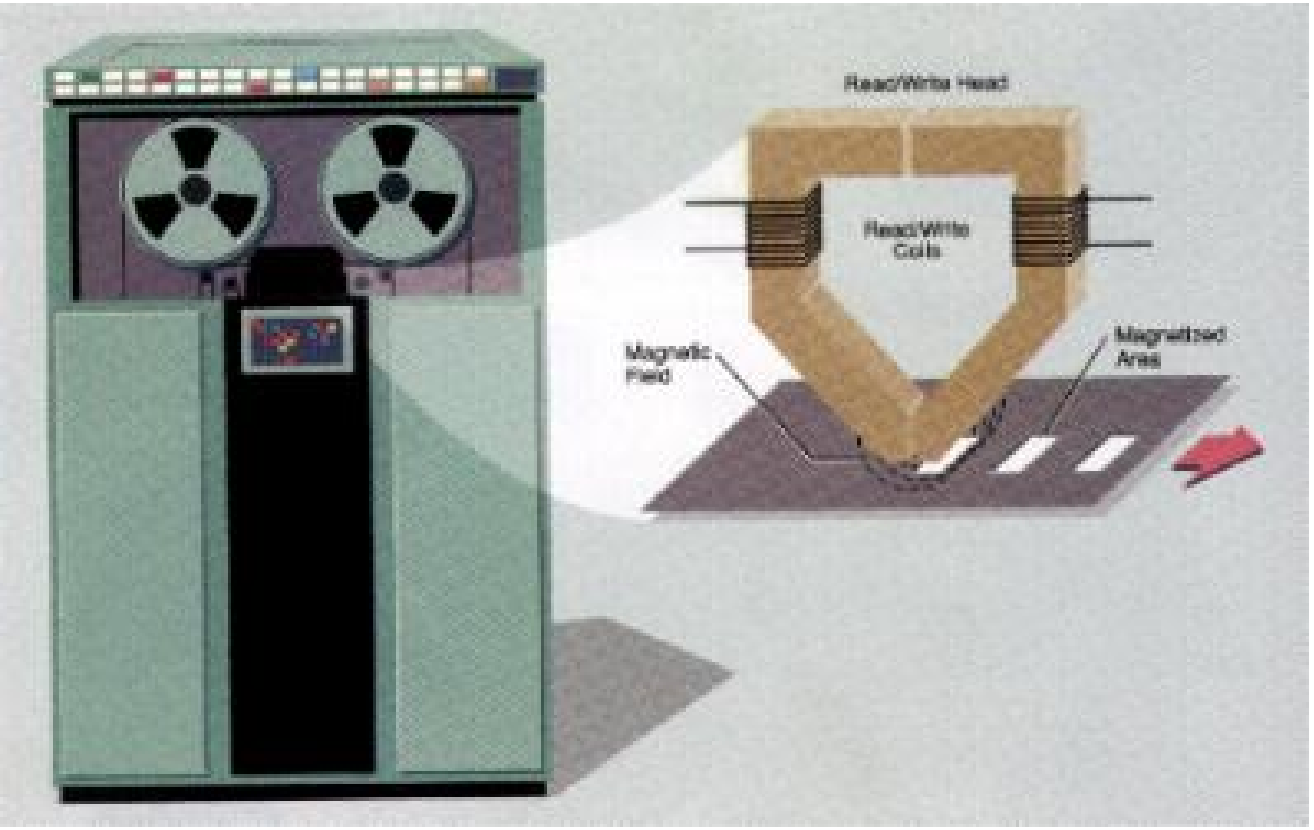
Eg: A=C1H



NOTE: The parity bit is shown in the top tract to simplify visualization.

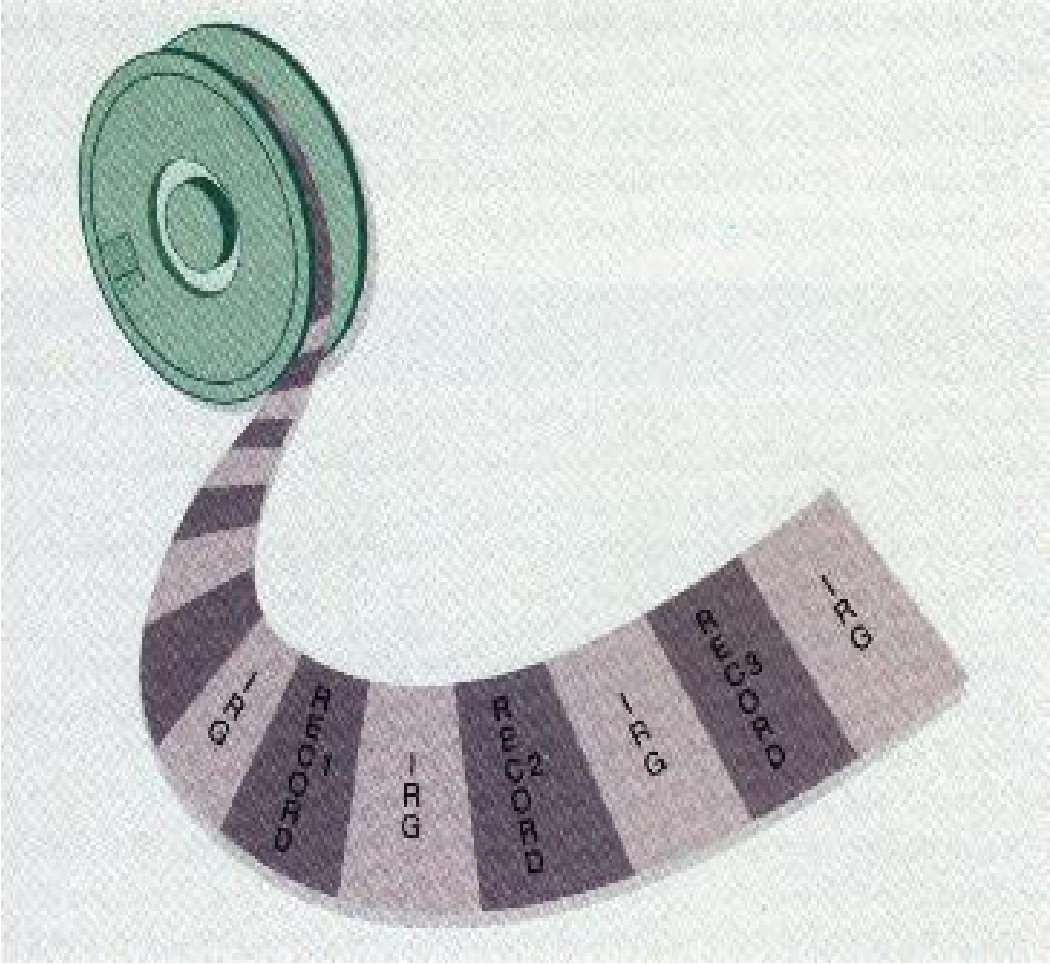
Data is represented vertically in columns, one character per column. This method of coding is identical to the Extended Binary Coded Decimal Interchange Code (EBCDIC) used to represent data in some computers' memory. In this way, eight bits and eight of the nine tracks are used to represent each character. The ninth bit and ninth track function as a parity bit.

A magnetic tape is mounted on a **tape drive** when a program needs the data it contains. The tape drive has a **read/write head** (which is actually an electromagnet) that creates or detects the magnetized bits as the tape moves past it (see picture below).



When the read/write head is reading data, it detects the magnetized spots and converts them into electrical pulses to send to the CPU.

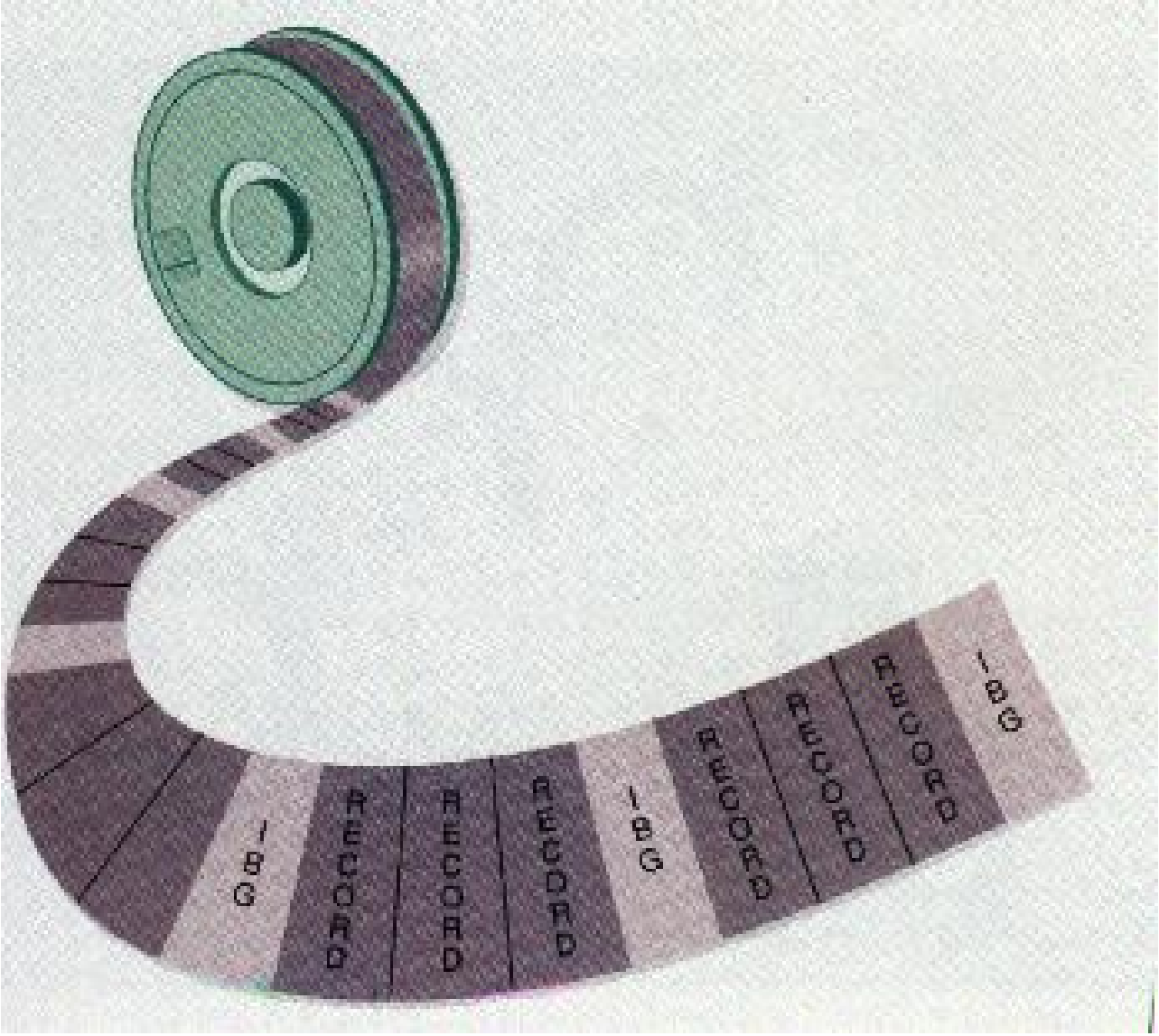
When writing data, the head magnetizes the appropriate spots on the tape, while erasing any data stored there previously. Individual records on magnetic tape are separated by **inter record gaps (IRGs)**, as shown . These gaps do not contain data but they perform a specific function



When a tape is being read, its entire contents are rarely read all at once. Rather, it is stopped when the end of a record is reached. The tape must then be accelerated to the proper speed before the next record can be read accurately. If this were not the case, the result would be similar to what happens when a phonograph record is played at the wrong speed. The IRG gives the tape time to regain the proper speed before the next record is read. **The length of the IRG depends on the speed of the tape drive**. If the tape drive is very fast, longer gaps are needed. A slower tape drive requires shorter gaps.

Magnetic tape

If the records stored on a tape are very short and the IRGs are long, it would be possible for the tape to be more than 50 percent blank, causing the tape drive to stop and accelerate constantly. To avoid this situation, records may be grouped, or blocked, together. These **blocked records**, or **blocks**, are separated by **inter block gaps (IBGs)** as shown in below.



Magnetic tape

Advantages

- Its the cheapest form of storage per megabyte of storage.
- Can store large amounts of data - up to 1 Terabyte per tape cartridge.
- Can be set up to do the back up overnight or over the weekend.

Disadvantages

- Serial access so can be quite slow to access data.
- Need a special piece of equipment to record and read the data on the tape.
- The data may be corrupted if the tape is placed near a strong magnetic field e.g. a magnet.

Characteristics of Magnetic Tapes

- No direct access, but very fast sequential access.
- Resistant to different environmental conditions.
- Easy to transport, store, cheaper than disk.
- Before, it was widely used to store application data; nowadays,it's mostly used for backups or archives.

Performance of tape drive

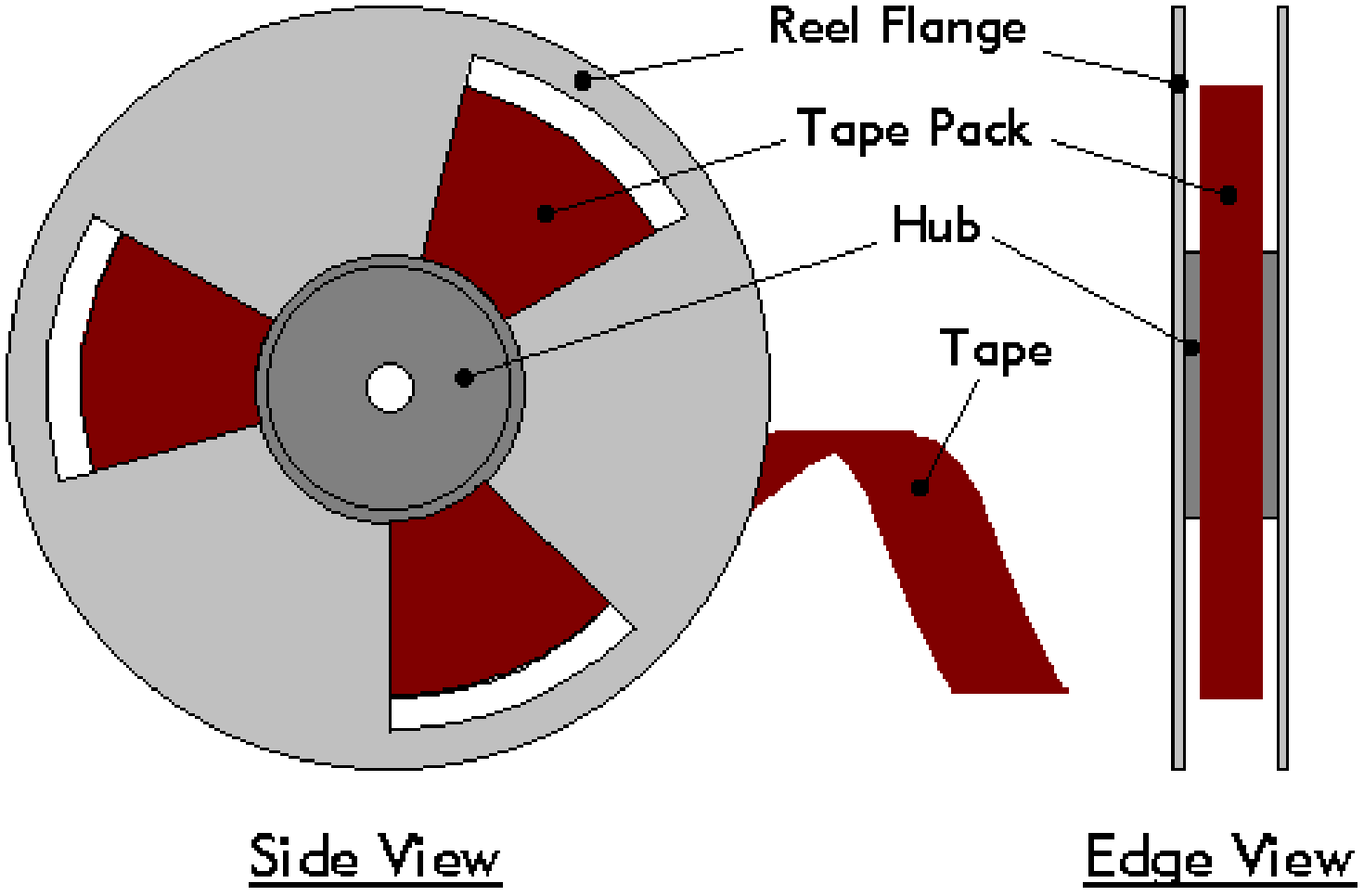
- Performance of tape drives can be measured in terms of 3 quantities:

Tape density, Tape speed, Size of inter block gap

- Tape density = 6250 bpi (bits per inch per track)
- Tape speed = 200 inches per second (ips)
- Size of interblock gap = 0.3 inch
- File characteristics:
- Number of records = 1,000,000
- Size of record = 100 bytes

Examples of Magnetic Media

- Some you are probably familiar with:
  - Cassette tapes
  - VHS video tape
  - Computer Tape



Magnetic Tape Uses Today

- Today, tape based systems are usually used for **backup purposes only.**

- Tape still provides the most cost effective method of storing larger amounts of backup information
  - Reliable as long as temperature is kept low and humidity conditions are kept right.

- Although hard disks are increasingly used as a backup mechanism, tapes are portable.

Magnetic Disk

- Magnetic disk is **a direct access** secondary storage device . It is a thin plastic or metallic circular plate coated with magnetic oxide and encased in a protective cover . Data is stored on magnetic disk as a magnetized spots . The presence of a magnetic spot represent the bit 1 and its absence represent the bit 0 .

Magnetic Disk –Storage Organization

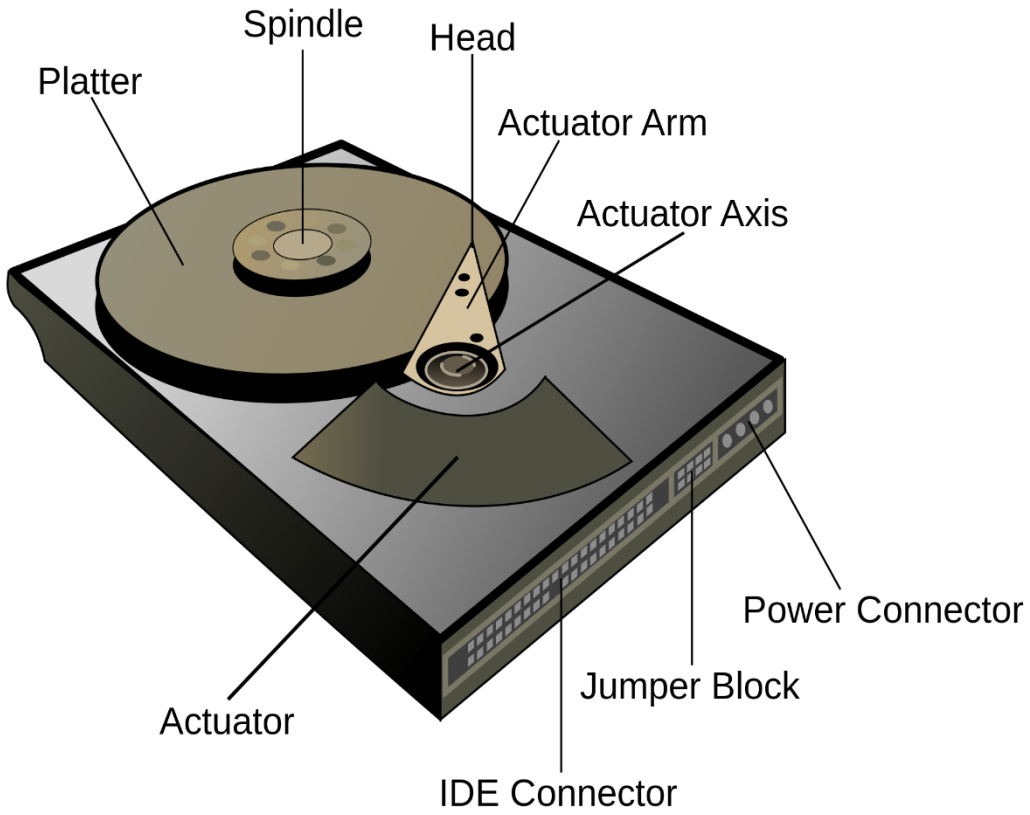
A **magnetic disk** is a cylindrical metal platter stores and retrieves data in much the same fashion as a phonograph record is played.

Each disk **platter** has a flat circular shape, like a phonograph record.

Its two surfaces are covered with a magnetic material, similar to magnetic tape.

Information is recorded on the surfaces.

The disk is rotated while a read/write head is positioned above its magnetic surface.

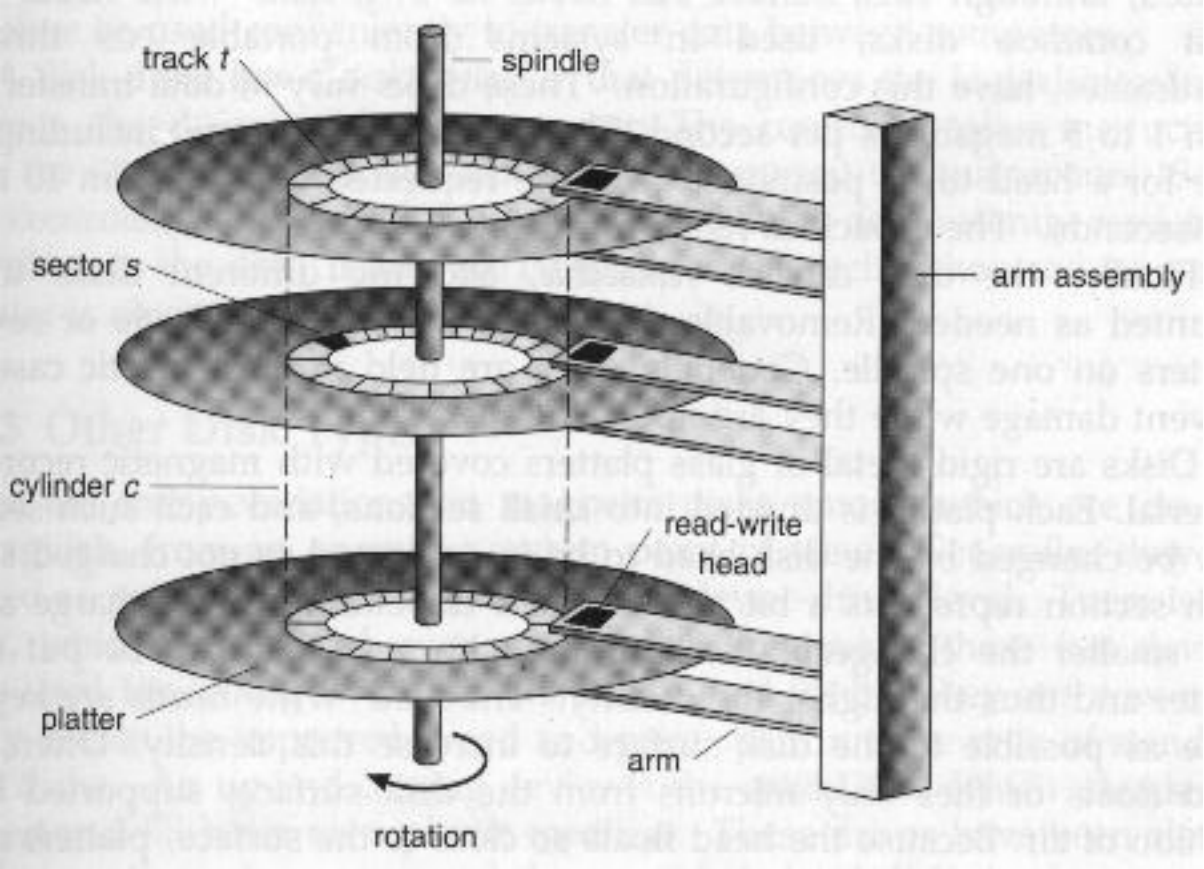


Magnetic Disks

- A disk's surface is divided into a number of invisible concentric circles called tracks.

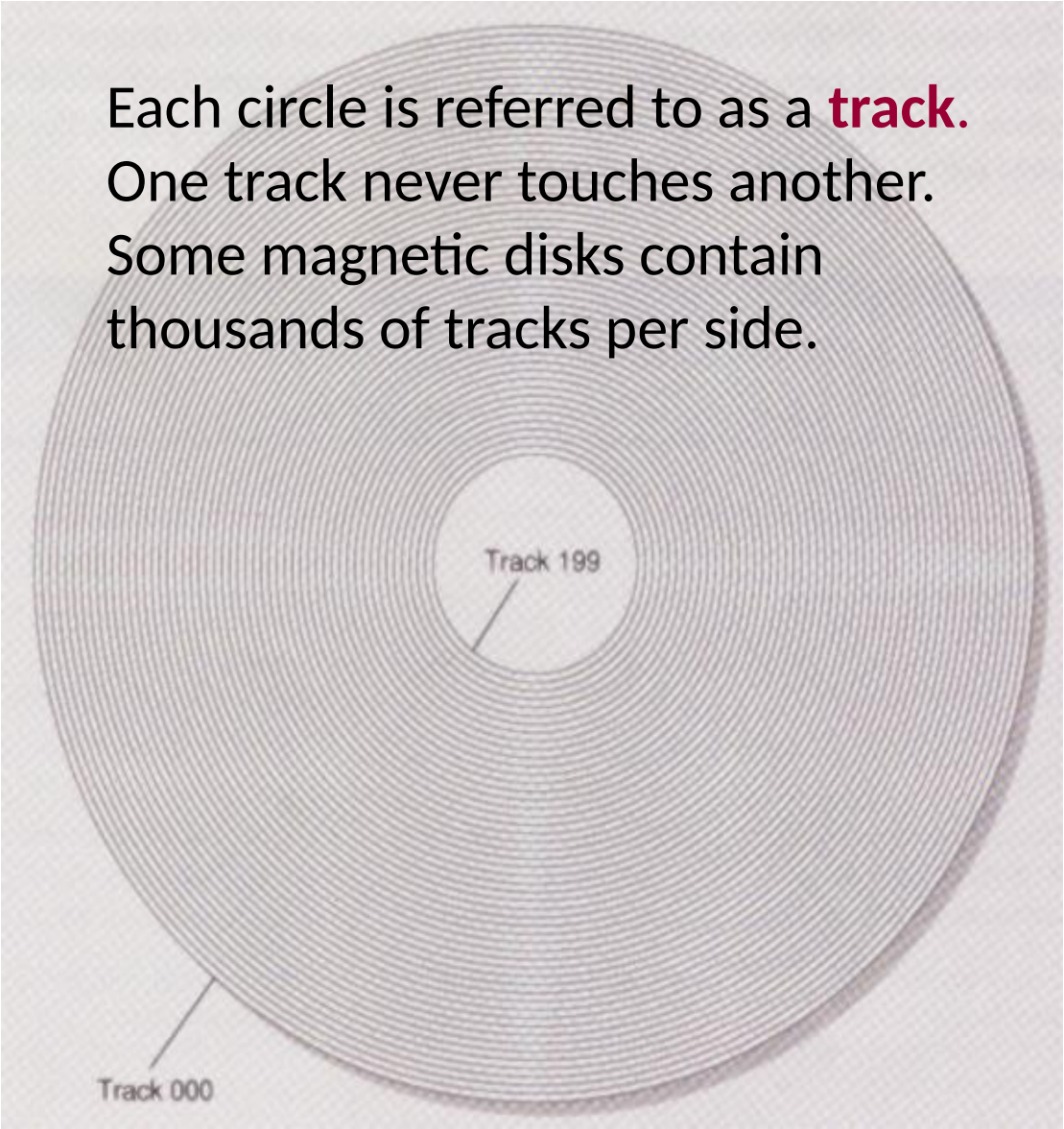
- The tracks are numbered started from outermost to innermost starting from zero.

- The number of tracks on a disk may be as few as 40 on small, low-capacity disks, to several thousand on large, high-capacity disks



Moving-head disk mechanism

In most disk storage devices, several disks are assembled to form a **disk pack** (see picture below).

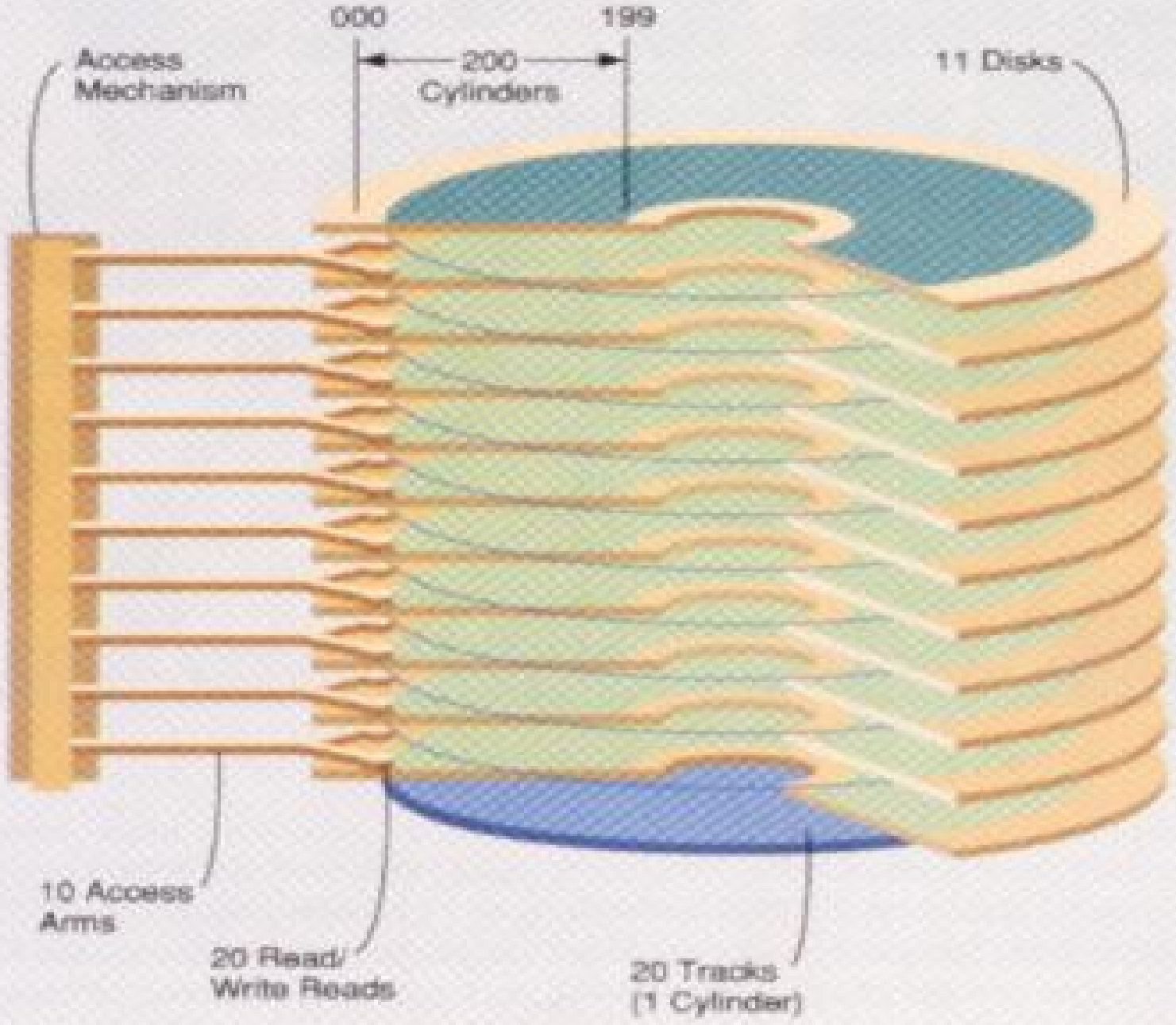


Each circle is referred to as a **track**. One track never touches another. Some magnetic disks contain thousands of tracks per side.

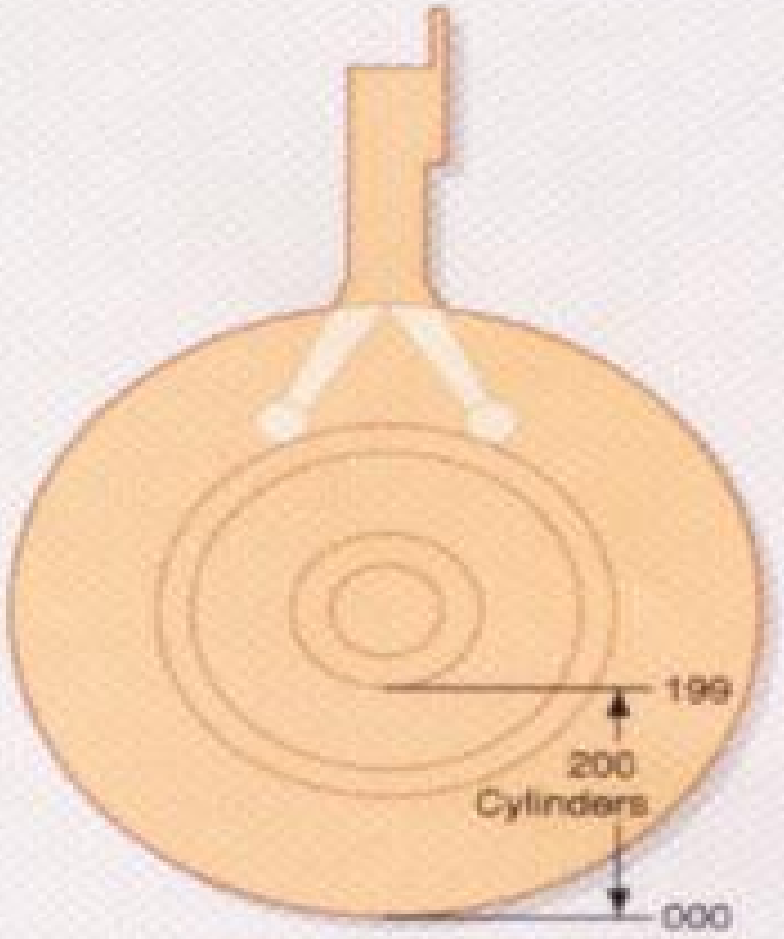
Magnetic Disk

The disk pack (shown below) has eleven disks and provides twenty usable recording surfaces.

The top and bottom surfaces are not used for storing data because they are likely to become scratched .



(a) Side View



(b) Top View

11- disk
22- surface
20 used surfaces
10 access arms(20 read /write readers)
200 track per disk

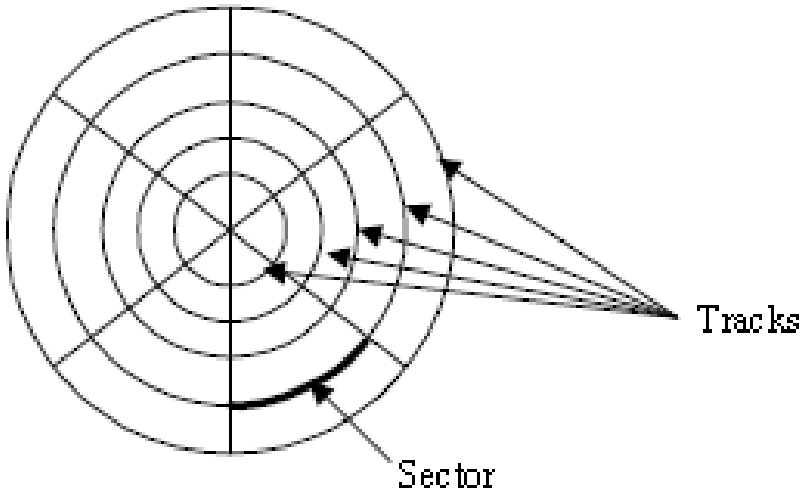
Magnetic Disk

A disk pack is positioned in a disk drive when the data on the pack is to be processed. The **disk drive** rotates all disks in unison at speeds up to 5,000 revolutions per minute.

The data on a disk is read or written by the read/write heads located between the disks. Most disk units have **one** read/write head for each disk recording surface. All the heads are permanently connected to an **access mechanism**. When reading or writing occurs, the heads are positioned over the appropriate track by the in-and-out movements of the access mechanism.

Magnetic Disk

When data stored on the surface of one disk in the disk pack is required, all heads move to the corresponding tracks on the surfaces of the other disks because they are connected to the same access mechanism.



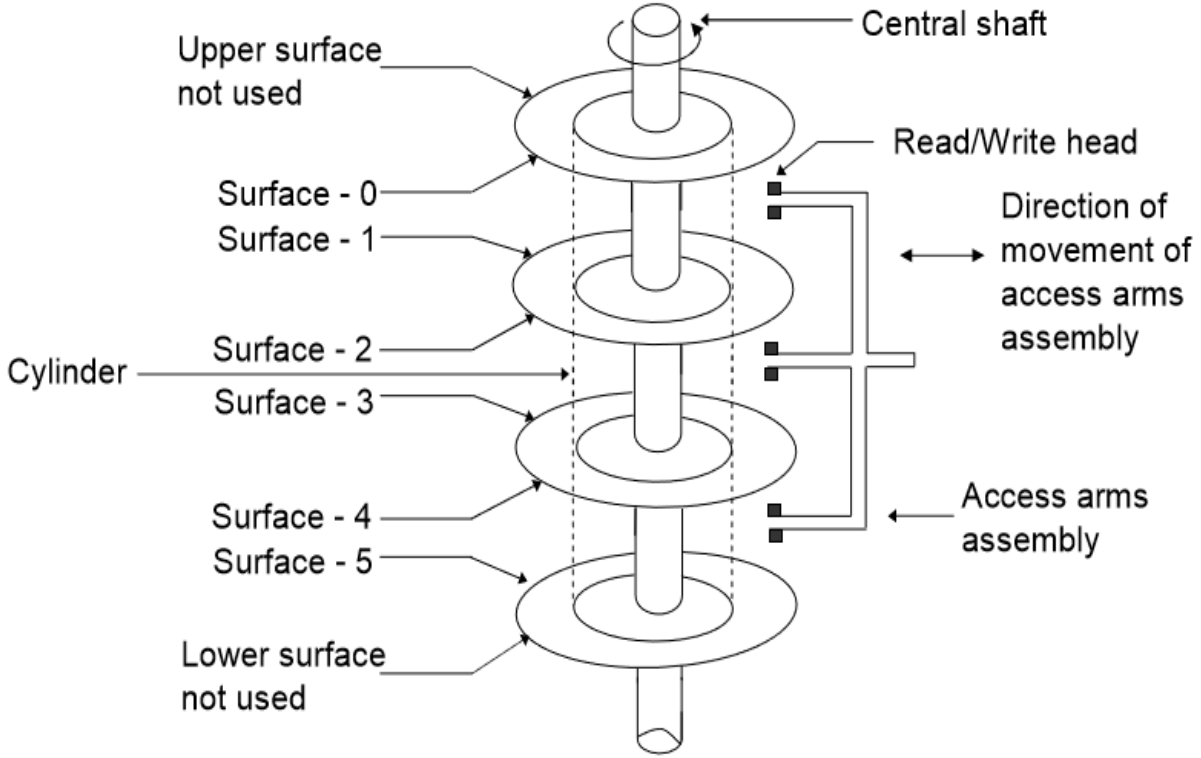
Since all the read/write heads move together, they are positioned over the same tracks on all disk surfaces at the same time making a cylinder(see picture above again).

The number of cylinders per disk pack equals the number of tracks per surface

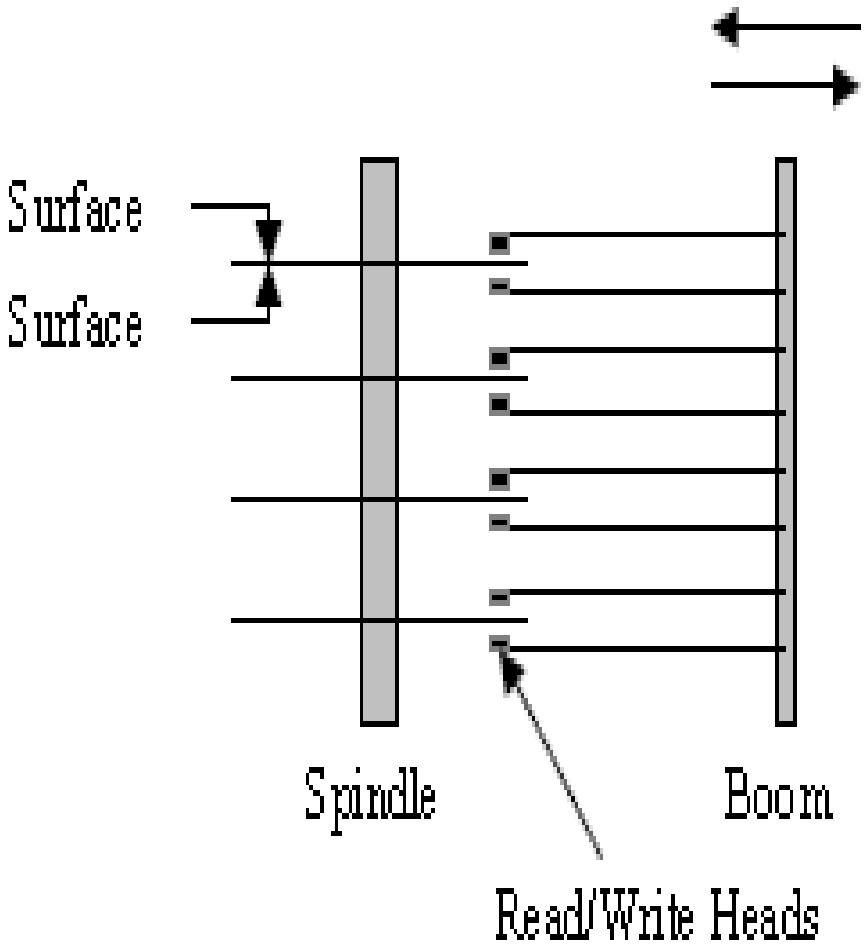
Disks contains concentric tracks. Track are divided into sectors. A sector is the smallest addressable unit in a disk

Cylinder: the set of tracks on a disk that are directly above/below each other

Magnetic Disk – Storage Organization (Illustrates the Concept of Cylinder)



No. of disk platters = 4, No. of usable surfaces = 6. A set of corresponding tracks on all the 6 surfaces is called a cylinder.



Magnetic Disk

Some disk units have one read/write head for each track. The access time is much faster with this type of disk unit since the access mechanism does not move from track to track. Units such as this are rarely used because they are very expensive.

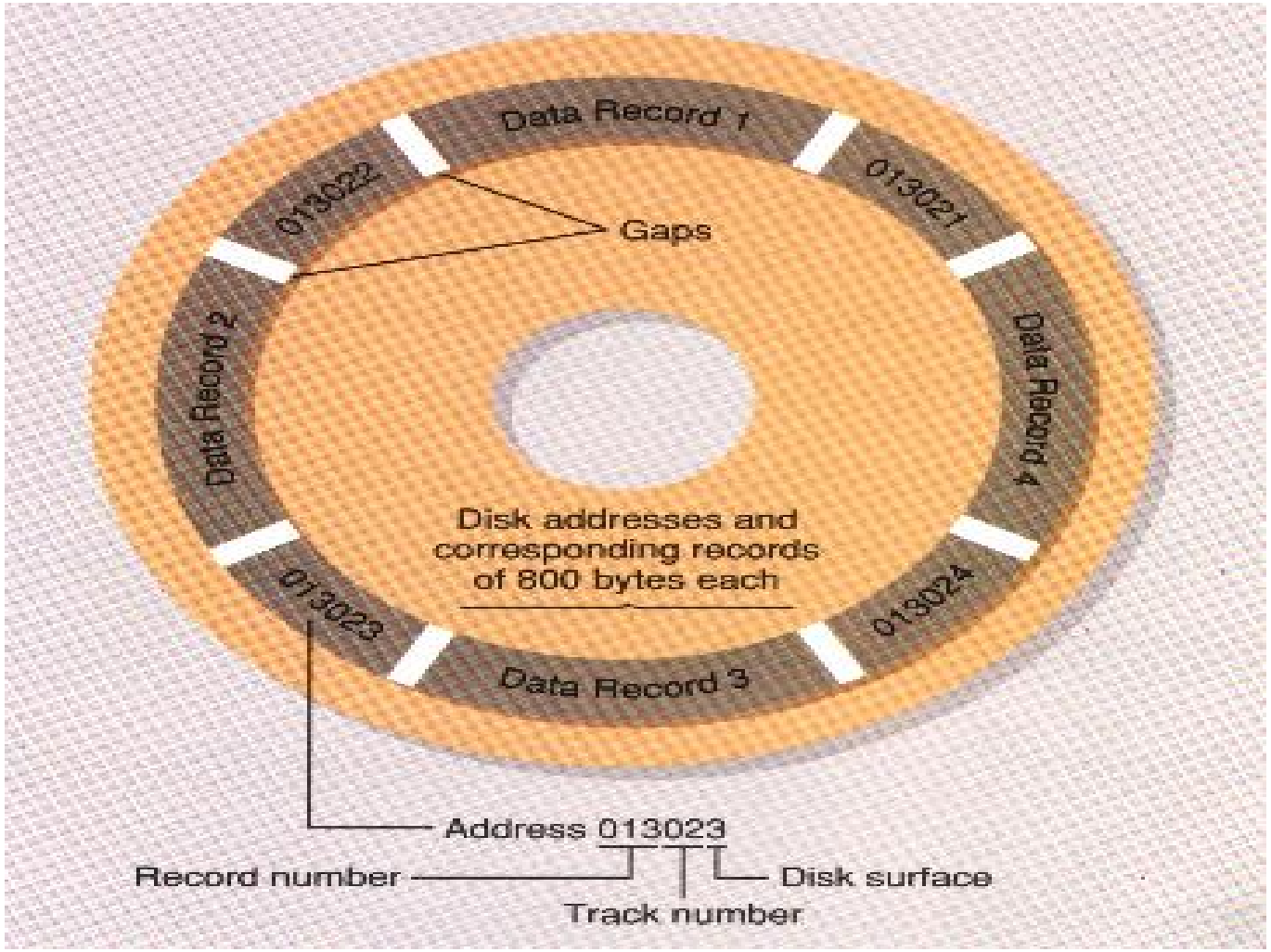
Each track on a disk can store the same amount of data even though the tracks get smaller toward the center of the disk.

Consider a disk pack with 4,000 usable tracks (20 surfaces x 200 tracks per surface) on which 7,294 characters can be stored on each track. The disk pack could conceivably store 29,176,000 characters of data (4,000 tracks x 7,294 characters per track).

Magnetic Disk

The computer locates data stored on a magnetic disk by its disk surface number, track number, and record number.

The numbers make up the data's **disk address**. The disk address of a record is stored immediately before the record (see picture below).



Magnetic Disk

Disk records are separated by gaps (gaps to help with synching.)similar to the inter record gaps on magnetic tape.

Also similarly, the presence of gaps in each track reduces the amount of data that can be stored on a disk. Therefore, the usable storage capacity in the disk pack described in the previous paragraph would be slightly less than the potential 29,176,000 characters.

Since disks provide direct access, they are typically used to store data that is accessed frequently. Depending on the disk drive, it is possible to read more than 1,000,000 characters per second.

Characteristics of Magnetic Disk

When a program reads a byte from the disk, the operating system locates the surface, track and sector containing the byte, then moves the entire sector into a special area in main memory.

Number of cylinders = Number of tracks in a surface

Track capacity = Number of sectors per track * Bytes per sector

Cylinder capacity = Number of surfaces * track capacity

Drive Capacity = Number of cylinders * Cylinder capacity

Example: solve the following problem:

It is given that:

- File characteristics:
  - Fixed length record= 50,000 records
  - Size of a record = 256 Byte
- Disk characteristics:
  - Number of bytes per sector = 512
  - Number of sectors per track = 63
  - Number of tracks per cylinder = 16

How many cylinders are needed???

1- each sector has 2 records
2- 63*16= 1008 sector /cylinder
3- 1008 *2 = 2016 record / cylinder
4- Number of cylinders is = 50000/2016=24.8 cylinder

Magnetic disk accessing time

The time to access a sector in a track on a surface is divided to

Time Component	Action
Seek time	Time to move the read/write arm to the correct cylinder
Rotational delay	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

Accessing time

1. Seek time = average time it takes to position a head over the correct track.
2. Rotational delay = average time it takes a sector to reach the head.
3. **Access time = seek time + rotational delay.**
4. Transfer time = time to read or write one sector

$T = b/rN$,

where b = bytes transferred,

r = RPMs,

N = bytes per track (which varies on multiple zoned disks).

Example:

Given that:

Average seek time=8msec
Average rotational delay=3msec
Spindle speed=10,000 rpm
Sectors per track= 170 sector
Sector size=512 byte

What is the average time to read one sector?

Transfer time=revolution time/ no of sectors per track
= (1/10,000)/170 min = 60/1700,000)sec=6/170 msec=0.035 msec

Average total time= average seek+ average rotational delay+ transfer time
=8+3+0.035=11.035 msec

ADVANTAGES OF MAGENETIC DISKS

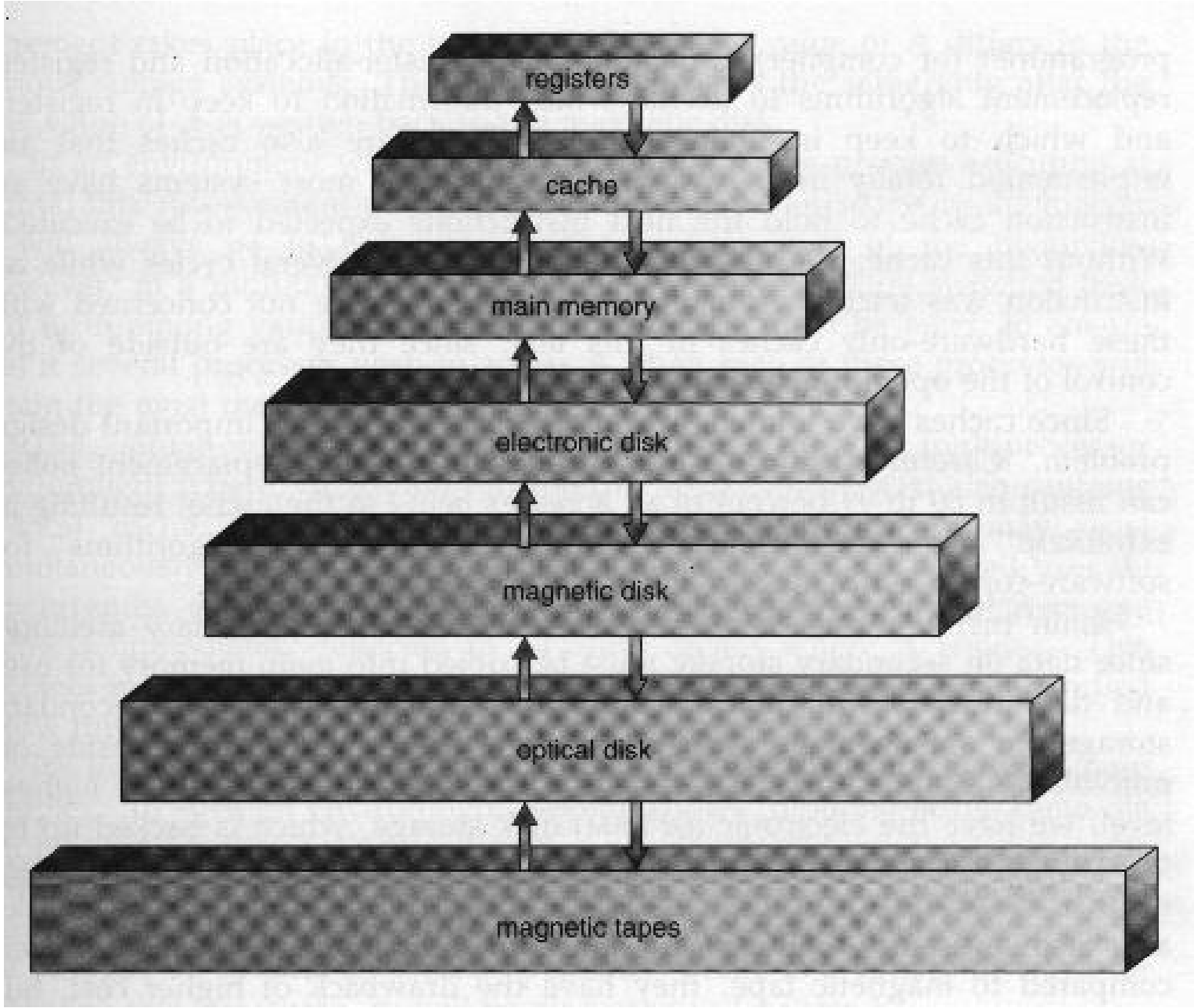
- ✓ More suitable than magnetic tapes for a wider range of applications because they support direct access of data.
- ✓ Suitable for both on-line and off-line storage of data.
- ✓ Due to their low cost and high data recording densities, the cost per bit of storage is low for magnetic disks.
- ✓ Can be erased and reused many times.
- ✓ Floppy disks and zip disks are compact and light in weight. Hence they are easy to handle and store.
- ✓ Very large amount of data can be stored in a small storage space.

LIMITATIONS OF MAGNETIC DISKS

- More difficult to maintain the security of information stored on shared, on-line secondary storage devices, as compared to magnetic tapes or other types of magnetic disks.
- Some types of magnetic disks, are not so easily portable like magnetic tapes.
- On a cost-per-bit basis, the cost of magnetic disks is low, but the cost of magnetic tapes is even lower

Storage Hierarchy

The wide variety of storage systems in a computer system can be organized in a hierarchy (see figure below) according to their speed and their cost. The higher levels are expensive, but are fast. As we move down the hierarchy, the cost per bit decreases, whereas the access time increases. This tradeoff is reasonable; if a given storage system were both faster and less expensive than another - other properties being the same - then there would be no reason to use the slower, more expensive memory. In fact, many early storage devices, including paper tape and core memories, are relegated to museums now that magnetic tape and semiconductor memory have become faster and cheaper.



Storage-device hierarchy

Some summery questions

- List the two most common types of storage devices.
- Explain the difference between Direct and Sequential access.
- Describe the most common use of Tape Cartridges.
- Rank the following in order from most expensive to least expensive: disk storage, primary memory, and tape storage.
- Rank the following from fastest to slowest data access times: disk storage, primary memory, and tape storage.