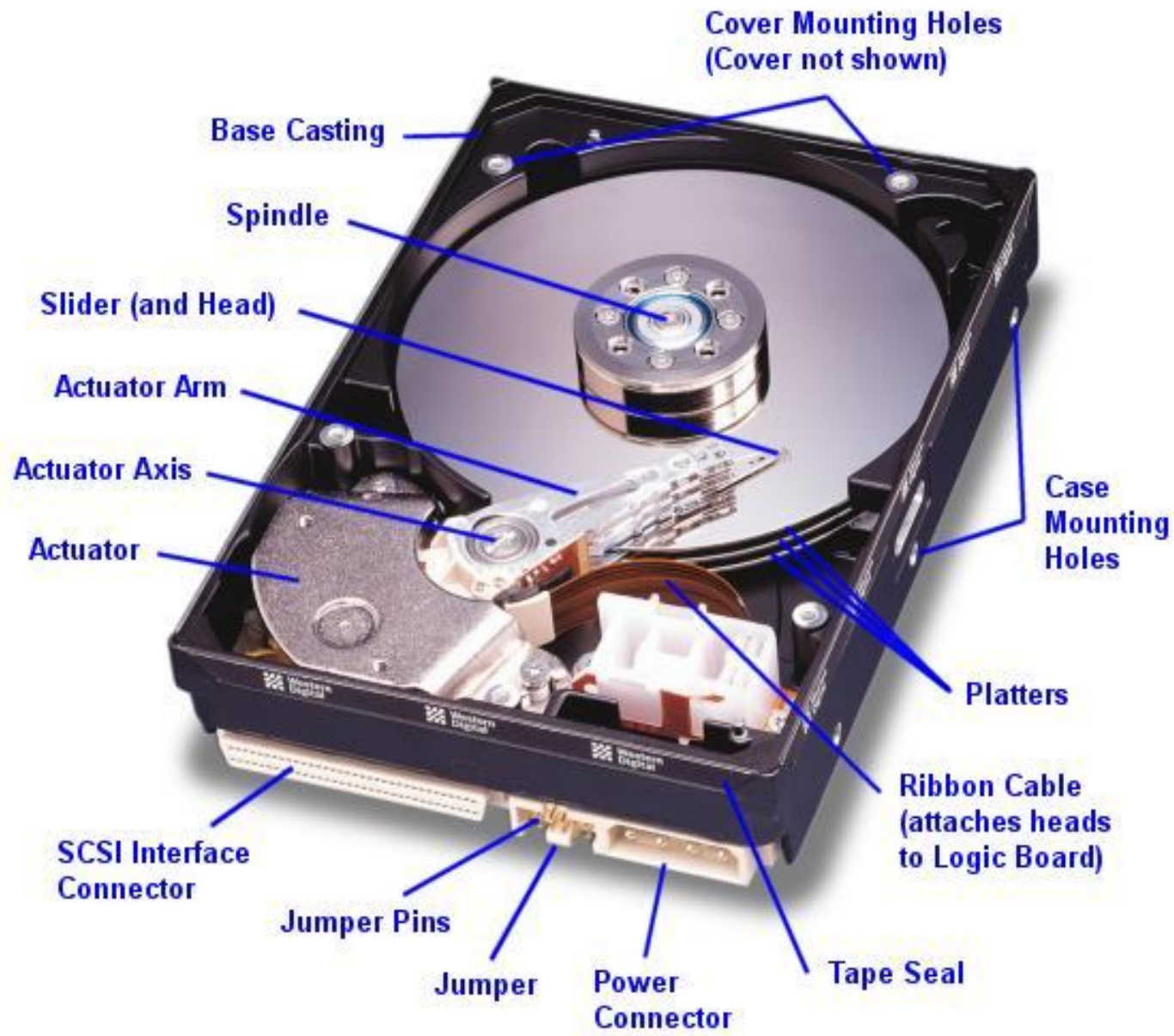


Hard disk drive

- The hard disk drive is a non volatile storage device that stores digitally encoded data on rapidly rotating rigid(i.e. hard)platters with magnetic platters with magnetic surfaces.
- Data is read in a random access manner, meaning individual blocks of data can be stored or retrieved in any order rather than sequentially.

Hard disk drive

- The hard disk drive in your system is the "data centre" of the PC.
- It is here that all of your programs and data are stored between the occasions that you use the computer.
- Your hard disk (or disks) are the most important of the various types of permanent storage used in PCs.
- The hard disk differs from the others primarily in three ways: size (usually larger), speed (usually faster) and permanence (usually fixed in the PC and not removable).



Following factor needs to closely watch when we choose the hard disk.

3.2.1 Hard disk drive mechanical part:

This includes hard disk physical construction, read /write head construction , its data density, RPM (Rotation per minute) etc.

3.2.2 Hard disk drive Onboard cache:

Cache is very fast memory and costly memory. It reserves as a buffer for best utilization of the data being read. The hard disk always has some cache RAM onboard.

3.2.3 Hard disk drive Interface:

This used for connection between the hard disk and other components, generally with motherboard.

The Hard disk Drive has following performance advantages over floppy disk drive:

1. Higher capacity of data storage
2. Faster access time of data
3. Higher data transfer rate
4. Better reliability of operation
5. Less data errors or data loss

Hard disk Geometry

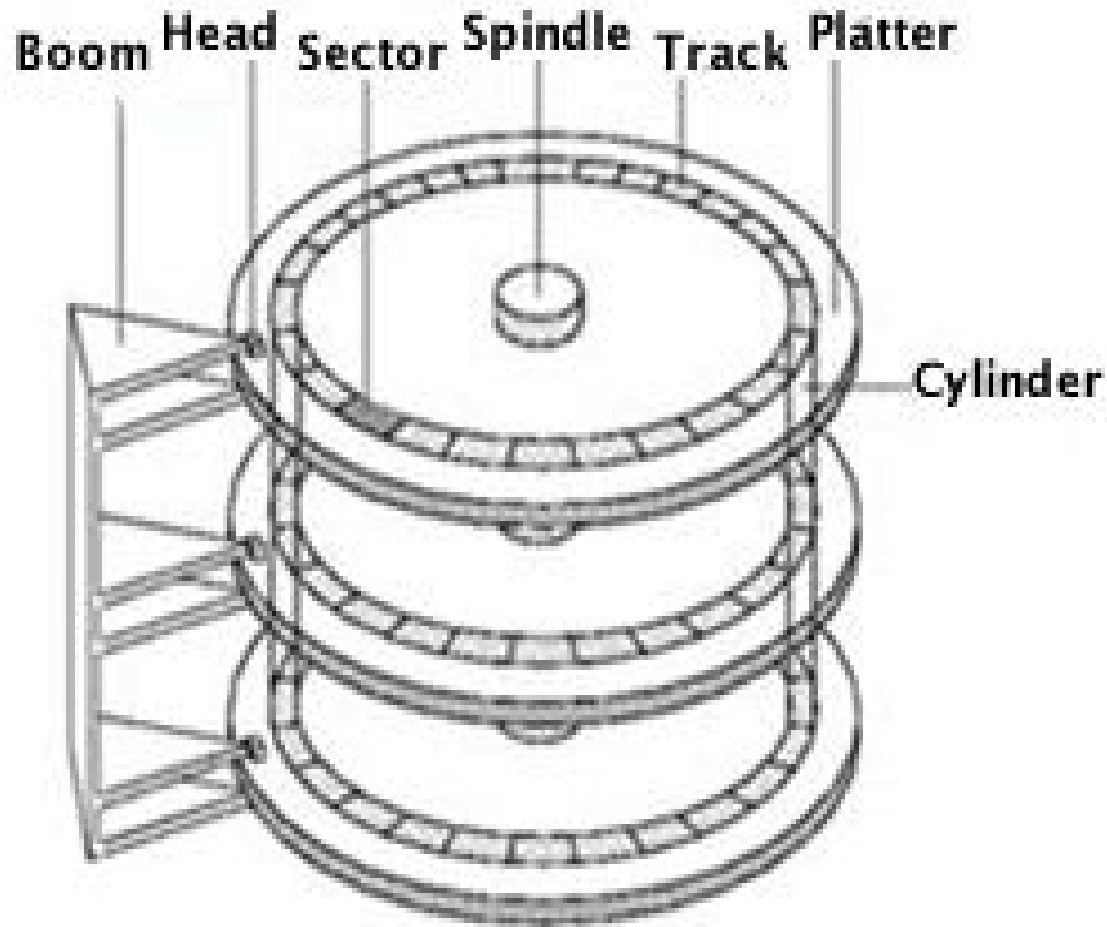
- Two kind of structure
 - 1) Physical Structure
 - 2) Logical Structure

1) **Physical Structure**

- 1) Disk Platter
- 2) Spindle motor
- 3) Read/Write Head
- 4) Head Actuator Mechanism

Hard disk Geometry

1) Physical Structure



Disk platters

- Every hard disk contains one or more flat disks that are used to actually hold the data in the drive.
- These disks are called *platters* (sometimes also "disks" or "discs").
- They are composed of two main substances: a *substrate* material that forms the bulk of the platter and gives it structure and rigidity, and a *magnetic media coating* which actually holds the magnetic impulses that represent the data.
- Generally, the hard disk has minimum 1 platter and maximum up to 10(even more possible) depend on the hard disk manufacturer.

Spindle motor

- The spindle motor, also sometimes called the spindle shaft, is responsible for turning the hard disk platters, allowing the hard drive to operate.
- The spindle motor is sort of a "work horse" of the hard disk. It must provide stable, reliable and consistent turning power for thousands of hours of often continuous use, to allow the hard disk to function properly.
- In fact, many drive failures are actually failures with the spindle motor, not the data storage systems.

Read/write head

- The read/write heads of the hard disk are the interface between the magnetic physical media on which the data is stored and the electronic components that make up the rest of the hard disk (and the PC).
- The heads do the work of converting bits to magnetic pulses and storing them on the platters, and then reversing the process when the data needs to be read back.

➤ conventional hard disk heads work by making use of the two main principles of electromagnetic force.

➤ 1) First is that applying an electrical current through a coil produces a magnetic field; this is used when writing to the disk.

➤ The direction of the magnetic field produced depends on the direction that the current is flowing through the coil.

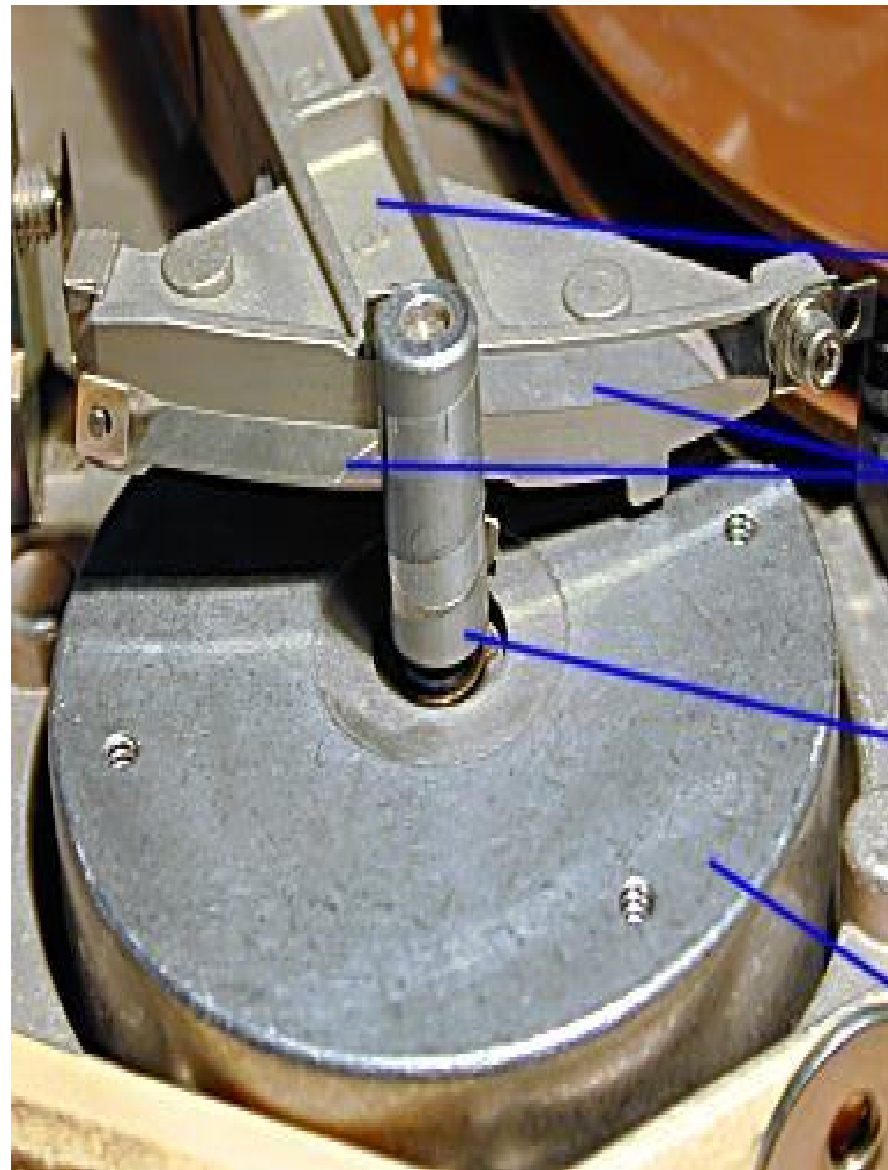
➤ 2) Second is the opposite, that applying a magnetic field to a coil will cause an electrical current to flow; this is used when reading back the previously written information.

Head actuator mechanism

- To moving read/write head of the hard disk drive on the disk platter is referred as head actuator mechanism.
- Head actuators come in two general varieties:
 - 1) Stepper Motor Actuator
 - 2) Voice coil Actuator

1) Stepper Motors

- Stepper motor rotates in fix angle with each step.
- Earlier low capacity, low cost hard disk drive used this types of actuator assembly to move read/write head.



Actuator
Pivot

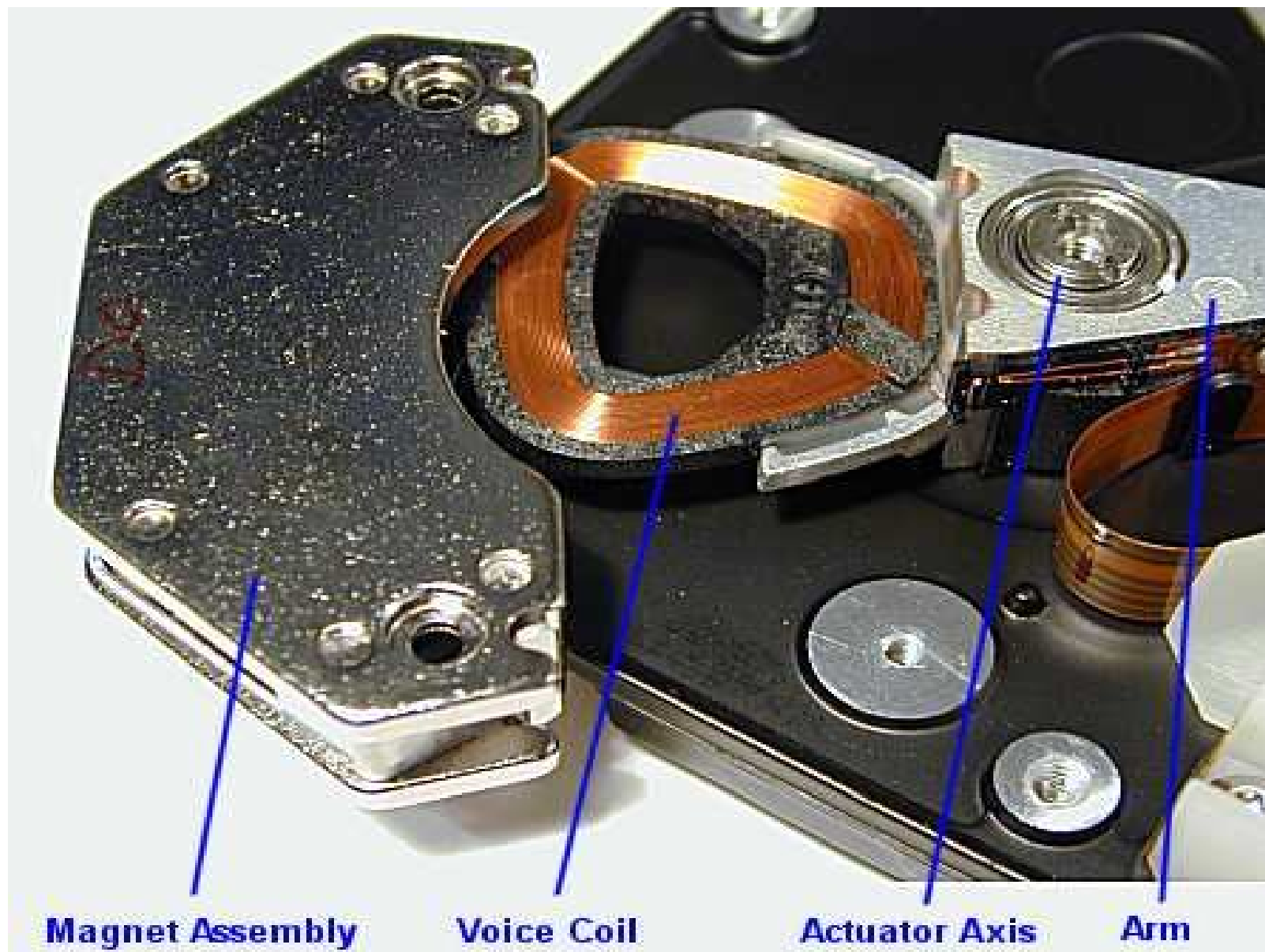
Split
Band

Motor
Shaft

Stepper
Motor

2) Voice Coils

- The actuator in a modern hard disk uses a device called a *voice coil* to move the head arms in and out over the surface of the platters, and a closed-loop feedback system called a *servo system* to dynamically position the heads directly over the data tracks.
- The voice coil works using electromagnetic attraction and repulsion.



3.3 hard disk logical structure

The following are the major logical part of the disk:

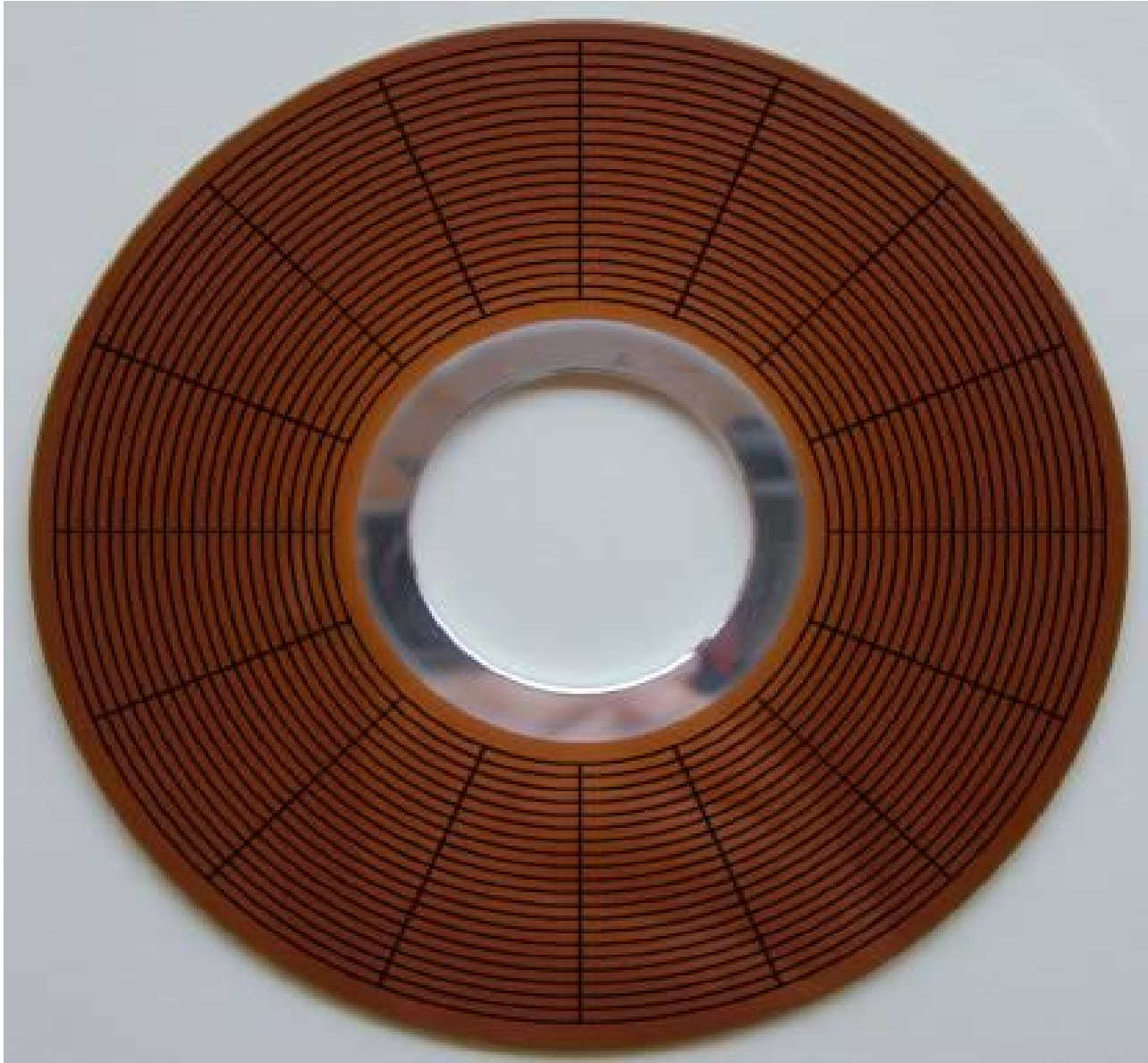
- I. Sides or heads
- II. Tracks
- III. Cylinder
- IV. Sector
- V. Zone

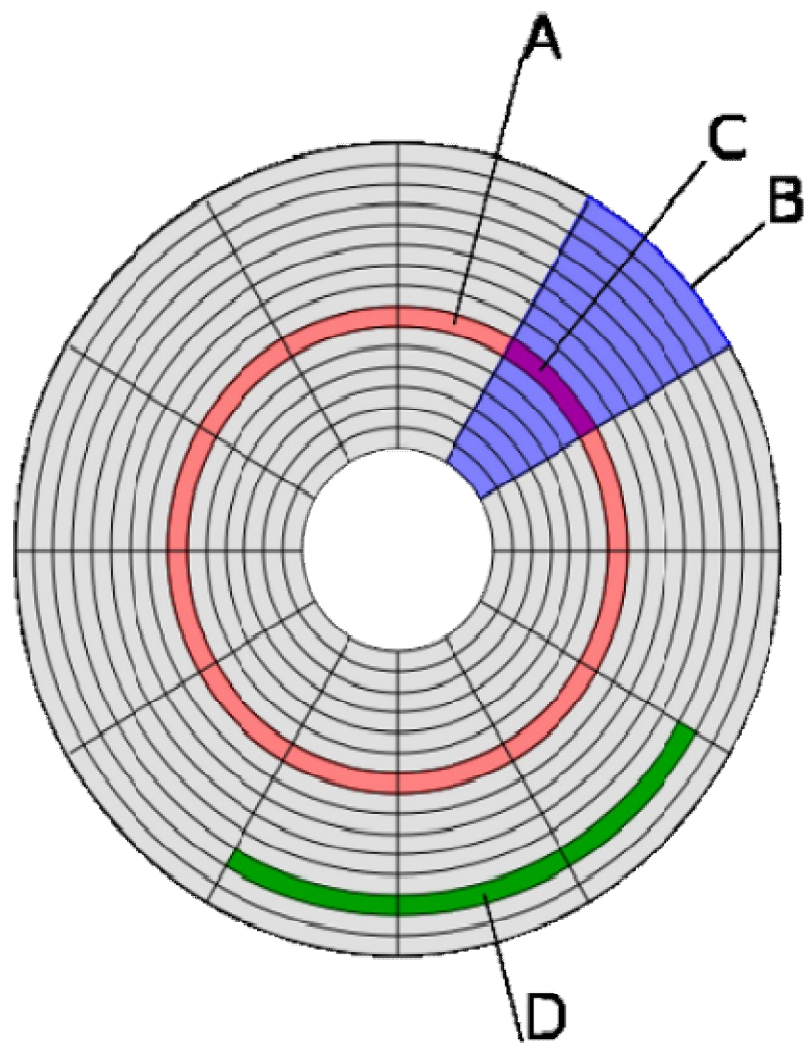
I. Sides or heads

- Drive with three platters one can read and write on six sides.
- If the drive is servo based then one side may be used for the servo information and 5 usable sides will be available.
- This type of drive is used in early system.
- Each side of the disk has a separate read / write head to read / write information on the disk surface.

II . Tracks

- Platters are organized into specific structures to enable the organized storage and retrieval of data.
- Each platter is broken into *tracks*--tens of thousands of them--which are tightly-packed concentric circles.





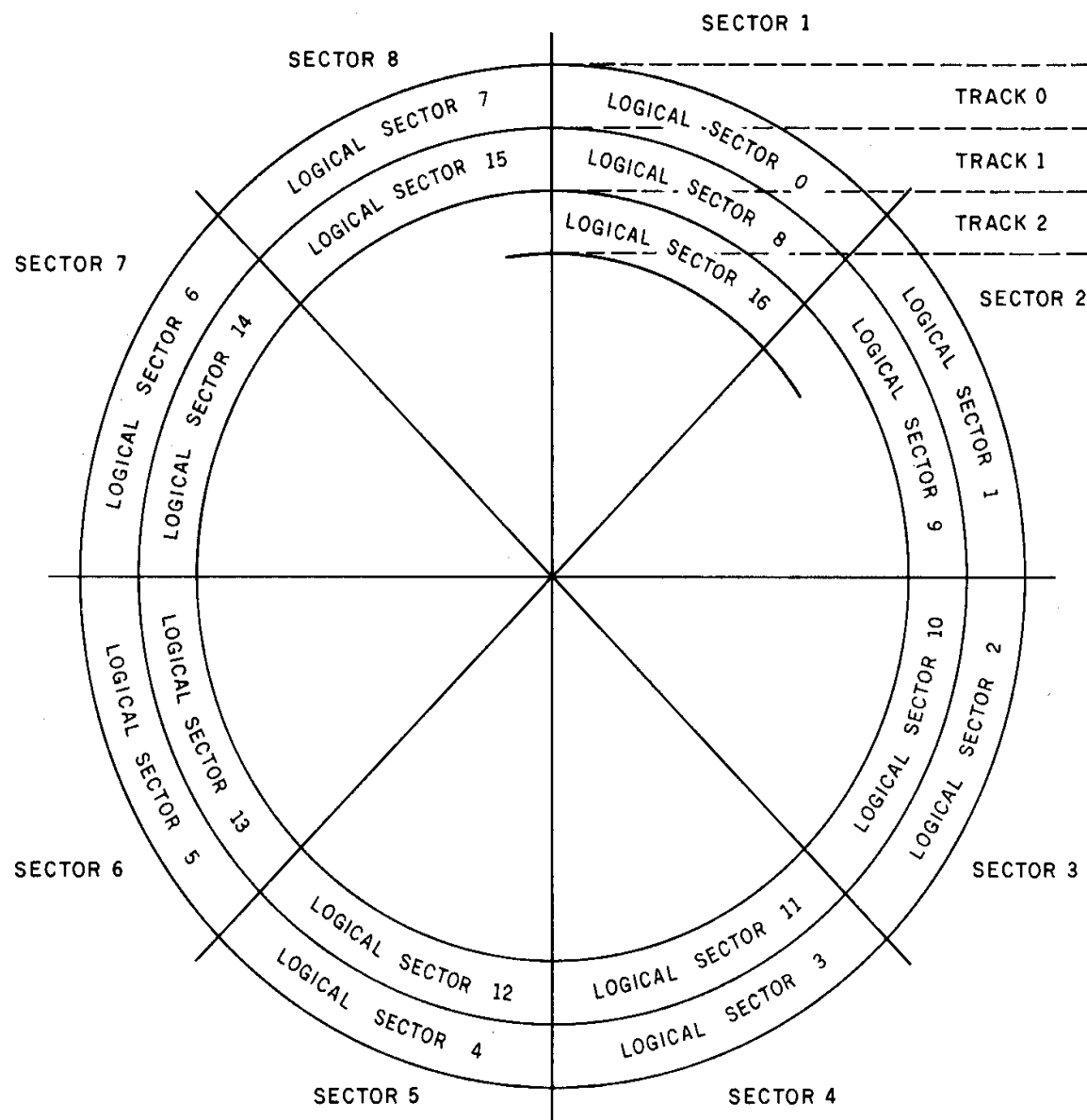
Hard Drive Structure:

A = track

B = sector

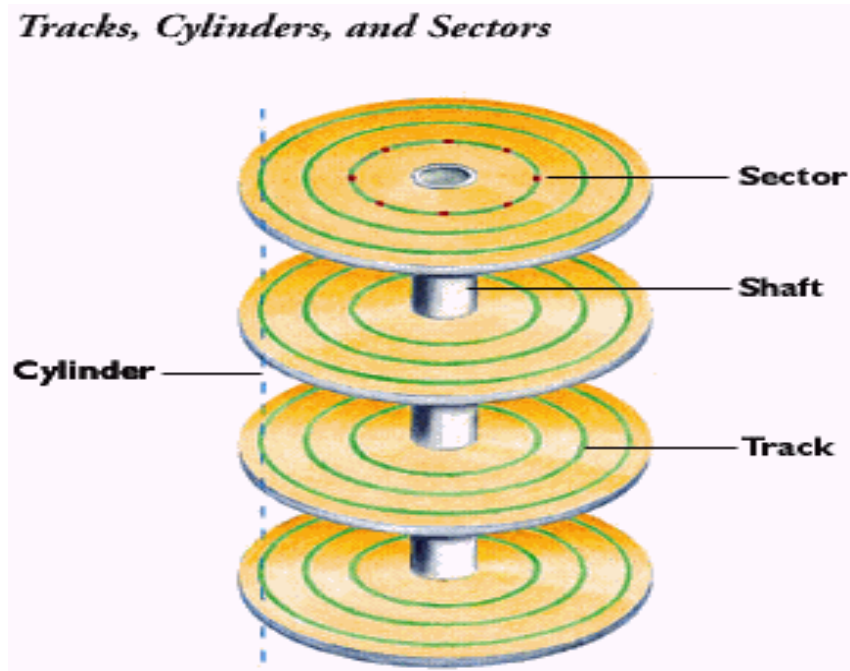
C = sector of a track

D = cluster



III . cylinder

The hard disk having more than one platter makes virtually a cylinder like structure on same tracks of different platter as shown in fig.



IV . Sectors

A track holds too much information to be suitable as the smallest unit of storage on a disk, so each one is further broken down into *sectors*.

A sector is normally the smallest individually-addressable unit of information stored on a hard disk, and normally holds 512 bytes of information.

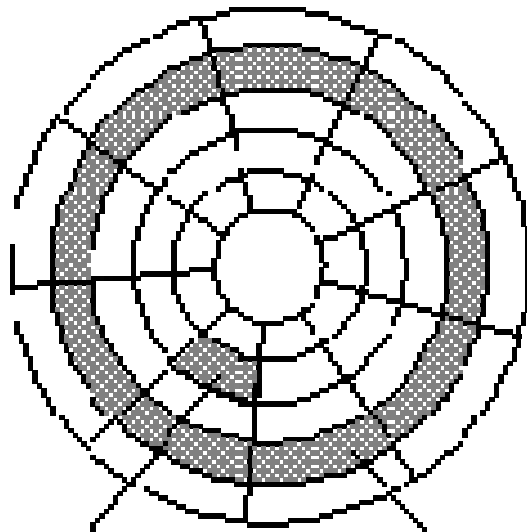
V. zone

When we logically divide the disk in tracks and sector due to circular shave the outer track or outer cylinder has much more area compared to the inner track of the disk drive.

To eliminate this wasted space, modern hard disks employ a technique called *zoned bit recording (ZBR)*, also sometimes called *multiple zone recording* or even just *zone recording*.

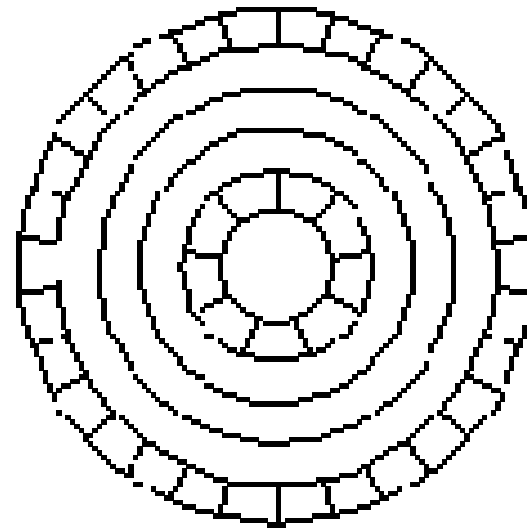
With this technique, tracks are grouped into zones based on their distance from the centre of the disk, and each zone is assigned a number of sectors per track.

Zoned-bit Recording



Sector

Track



Zoned-Bit Recording

Loading Zone

Landing Zone refers to the inner space of the hard disk where the read/write rests.

Landing zone is provided in every hard drive to avoid unnecessary contact of read/write head with the platters thereby reducing the chances of data corruption. Read/write head rests in the landing zone until it receives a command to make a move to many different addresses to perform data storage or retrieval task.

In other words, landing zone is a rest room for the read/write heads.

MBR(Master Boot Record)

The Master Boot Record (MBR) is the information in the first sector of any hard disk that identifies how and where an operating system is located so that it can be boot (loaded) into the computer's main storage or random access memory.

Disk performance Characteristics

➤ Hard disk drives also have some certain performance characteristics which define how good they are.

➤ Following are characteristic of disk.

1. Seek Time
2. Access Time
3. Latency
4. Data Transfer Rate

Seek Time

- The seek time of a hard disk measures the amount of time required for the read/write heads to move between tracks over the surfaces of the platters.
- Switching between tracks requires the head actuator to move the head arms physically, which being a mechanical process, takes a specific amount of time.

Access time

- The access time or response time of a rotating drive is a measure of the time it takes before the drive can actually transfer data.
- The key components that are typically added together to obtain the access time are: seek time and latency.

latency

- The hard disk platters are spinning around at high speed, and the spin speed is not synchronized to the process that moves the read/write heads to the correct cylinder on a random access on the hard disk.
- Therefore, at the time that the heads arrive at the correct cylinder, the actual sector that is needed may be anywhere.
- After the actuator has completed its seek to the correct track, the drive must wait for the correct sector to come around to where the read/write heads are located. This time is called latency.

Latency

- Latency is directly related to the spindle speed of the drive.
- The faster the disk is spinning, the quicker the correct sector will rotate under the heads, and the lower latency will be.

Data Transfer Rate

- The data transfer rate is commonly used to measure how fast data is transferred from one location to another.
- The data transfer rate of a drive (also called throughput) covers both the internal rate (moving data between the disk surface and the controller on the drive) and the external rate (moving data between the controller on the drive and the host system).
- The measurable data transfer rate will be the lower (slower) of the two rates. Data transfer rates are typically measured in bits per second (bps).

Hard disk Interface

The drive's interface is the physical connection of the drive to the PC's expansion bus.

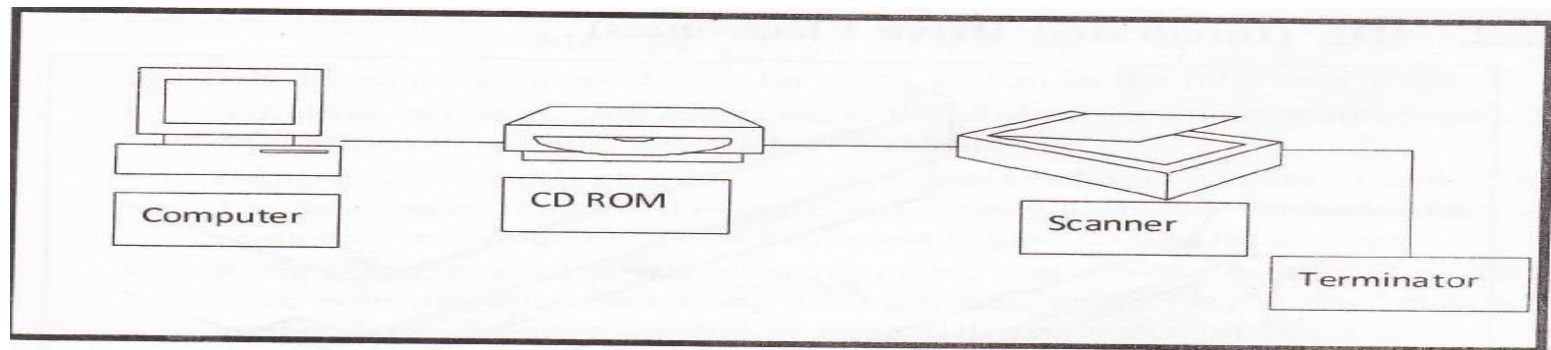
- SCSI
- IDE
- EIDE
- SATA
- USB
- RAID
- IEEE
- Solid State Drive

Small Computer System Interface(SCSI)

- The popular hard disk interface used in PCs today is the *Small Computer System Interface*, abbreviated *SCSI* and pronounced "skuzzy".
- SCSI is a system level interface instead of device level interface. A device level interface is designed for particular device and the signals used in that interface will not work with other devices.
- A SCSI connection is support number of devices on an expansion bus. A SCSI bus can support up to 8 different devices. New devices can be added to the system in daisy chain.

Small Computer Systems Interface(SCSI)

- Each new device is connected at the end of the old devices as shown in figure.



- The SCSI adapter card used for connecting SCSI device to the system.

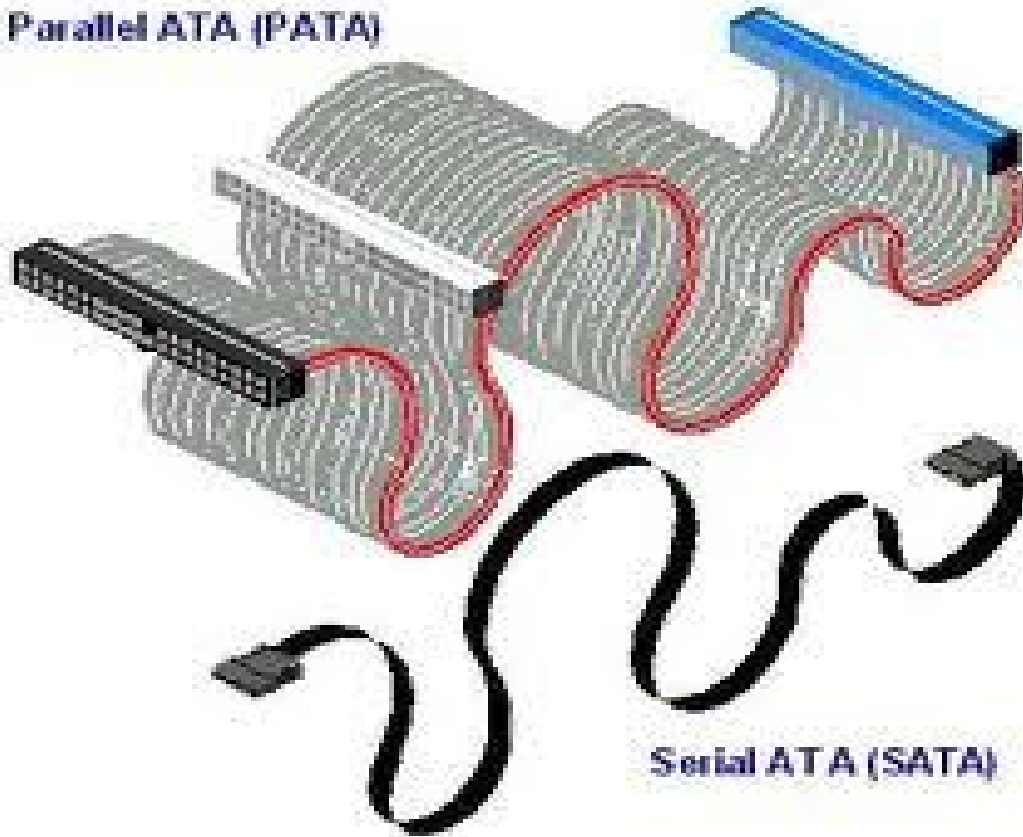
- I/O port is treated as one of the device this leaves space to connect seven more devices in a single SCSI host adapter. These devices can be SCSI compatible CD ROM drive, printer etc.
- A SCSI compatible drive is basically an ATA IDE hard disk drive with SCSI adapter embedded in its circuit. This is the reason these drives are also known as “Embedded SCSI” drives.

Integrated Drive Electronics (IDE)

- The most popular interface used in modern hard disks--by far--is the one most commonly known as *IDE*.
- This interface is also known by a truly staggering variety of other names such as *ATA*, *ATA/ATAPI*, *EIDE*, *ATA-2*, *Fast ATA*, *ATA-3*, *Ultra ATA*.
- The Compaq and western digital realized that one of the biggest problem with the ST-506 / 412 interface was its controller was away from the drive.
- As the distance between controller and the drive increased, there may be chance of data lost.
- They integrated the controller in drive itself. Which called the IDE. These drives are also known **Parallel Advanced Technology Attachment(PATA)**.

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Parallel ATA (PATA)



Serial ATA (SATA)

The IDE drive connected with the main system in the following ways:

- ✓ IDE drive can be directly connected to the I/O bus slot on the motherboard.
- ✓ Using 40 pin wire cable the IDE drive is connect to the bus adapter on motherboard.
- ✓ If the motherboard has IDE connector one can directly connected to the IDE drive with this connector using 40 pin wire cable.

Based on type of the system bus there are three type of IDE:

- ATA IDE
- XTA IDE
- MCA IDE

AT ATTACHMENT IDE (ATA IDE)

- ✓ This is among most popular type IDE interface, which works with 16 bit ISA and EISA buses.
- ✓ The 40 pin connector and the interface used by these drive was later standardized by an ANSI committee.
- ✓ The BIOS provided on the AT system to support the ATA IDE drives with any problem.

XT IDE

- 8 bit XT IDE interface was made only for the IBM PS/2 system.
- In most of this system the IDE connector was built in the motherboard itself.
- This type of drive is available in the maximum storage capacity of 40 MB.

MCA IDE

- MCA IDE was introduced by the IBM for the MCA bus, which was used by early IBM system.
- Some ATA IDE adapters are available in the market that can be used on the MCA bus computer; these adapters allow ATA IDE drives to be connected to a MCA bus based system.

EIDE

- Enhanced or Extended IDE was introduced by the western Digit(WD).
- This interface allows the BIOS to supports up to 8 GB large hard disk drives.
- This interface some times refers as ATA-2 interface. EIDE supports very high speed for data transfer.
- EIDE interface can allow connecting other devices like tape drive, CD-ROM etc. EIDE has high speed interface for high capacity hard disk drives.

Comparison between ATA and scsi

ATA Interface:

ATA is a common interface used in many personal computers before the emergence of SATA. It is the least expensive of the interfaces.

Advantages

- Low costs
- Large capacity

Disadvantages

- older ATA adapters will limit transfer rates according to the slower attached device.
- Only ONE device on the ATA cable is able to read/write at one time.
- Limited standard for cable length.

SCSI Interface:

SCSI is commonly used in servers and more in industrial applications than home users.

Advantages

- Faster
- Wide range of applications
- Better scalability and flexibility in Arrays

Disadvantages

- Costs
- Not widely supported
- Many , many different kinds of SCSI interfaces
- SCSI drives have a higher RPM, creating more noise and heat

SATA (serial ATA)

- A serial version of the ATA interface, which has been standard hard disk interface for desktop PCs for more than two decades.
- SATA was introduced in 2002 at significantly higher speed, transferring data in each direction at 1.5 Gbps. A year later, SATA II increased speed to 3Gbps.
- SATA provides point to point channel between motherboard and drive rather than the master slave architecture in the parallel technology.
- SATA uses a four wire shielded cable up to one meter in length compared to the wide, flat, 18" PATA cables.



USB



- USB hard drives are becoming popular as most computers now have ports and USB connections in them.
- Advantages of external hard drives is that the computers and laptops have a chance of losing data all the time and also theft is very common as far as laptop is concerned.
- External hard drives are ideal for backing up your hard drive or storing from your main hard drive.
- Now a day 1 TB hard disks are also very common as the backup drives.

RAID

Redundant Array of Independent Drives (or Disks) also known as Redundant Array of Inexpensive Drives (or Disks).

RAID offers different schemes for increased data reliability and/or I/O performance.

Most schemes are numbered and referred to as levels. RAID began as a collection of such five levels.

RAID Basic Functions

- Fundamentally, RAID combines multiple hard disks into a single logical unit. There are two ways this can be done: in hardware and in software.
- Hardware combines the drives into a logical unit in dedicated hardware which then presents the drives as a single drive to the operating system.
- Software does this within the operating system and presents the drives as a single drive to the users of the system.

RAID levels-

RAID 0: Striped Set (2 disks minimum) without parity.

RAID 1: Mirrored Set (2 disks minimum) without parity.

RAID 3 and RAID 4: Striped Set (3 disk minimum) with Dedicated parity

RAID 5: Striped Set (3 disk minimum) with Distributed Parity.

RAID 6: Striped Set (4 disk minimum) with Dual Distributed Parity.

IEEE

Firewire port or IEEE 1394 was first developed in 1990 by Apple and worked as a serial bus interface for high speed data transfer.

Transfer large amounts of data at very fast speed.

It connects camcorders and video equipments to the computer. Data travels at 400 to 800 megabits per second.

Three variants:

4-Pin FireWire 400 connector

6-Pin FireWire 400 connector

9-Pin FireWire 800 connector.

- IEEE 1394 is a type of connection often found on laptops.
- It is used for connecting peripherals such as external hard drives and some types of cameras and digital video camcorders to your computer.
- It can also be used to attach two Mac computers to each other and transfer data from one to another.

Solid state drive(ssd)

- A solid-state drive (SSD) is a data storage device that uses solid-state memory to store persistent data.
- A solid-state drive (SSD) , though it contains no actual disk) is a data storage device using integrated circuit assemblies as memory to store data persistently.
- SSDs use flash memory, which retains data without power. For applications requiring fast access, but not necessarily data persistence after power loss, SSDs may be constructed from random-access memory (RAM). Such devices may employ separate power sources, such as batteries, to maintain data after power loss.

➤ SSDs have been appearing in ultra-mobile PCs and a few lightweight laptop systems, adding significantly to the price of the laptop, depending on the capacity, form factor and transfer speeds.

Hard disk drive installation process

The main steps involved in the installation of a hard disk are

1. Collect all the parts required for installing the drive like Drive with controller, Data Cable, jumpers, screws & screw driver.
2. Turn off the power and remove the power cable from the socket. Remove the system unit cover
3. Check the master/slave jumper settings on the drive. Layout of jumper settings and HDD parameters are given on the HDD itself (Study the lay out from the lab manual)

4. Attach the data/control cable to the drive. Make sure that the alignment of the cable is correct.
5. Attach the power supply cable properly
6. Place the HDD in the bay and insert and tighten the mounting screws.
7. Power up the system.
8. Watch out the booting procedure displayed on the monitor and check whether the HDD is detected properly
9. Boot from floppy disk/CD and ***Partition the hard disk using FDISK or DM utility***
10. ***Format the disk and transfer operating system files***

Preparation of hard disk for software installation

For installing operating system on new or blank hard disk drive there should require two basic steps:

- A) Disk partition
- B) Disk formatting

Disk partition

FDISK OPTION

Current fixed disk drive: 1

Choose one of the following:

1. Create DOS Partition or logical drive

2. Set Active partition

3. Delete partition or logical DOS drive

4. Display partition information

5. Change current fixed disk drive

Enter Choice [1]

Press esc to exit FDISK

Create DOS partition or Logical DOS Drive

Current fixed disk drive:1

Choose one of the following:

- Create Primary DOS partition
- Create Extended DOS partition
- Create Logical DOS Drive in the Extended DOS Partition

Enter Choice [1]

Press Esc to exit FDISK

Disk formatting

There is basically two type of formatting for disk:

1. Low-Level Formatting
2. High-Level Formatting

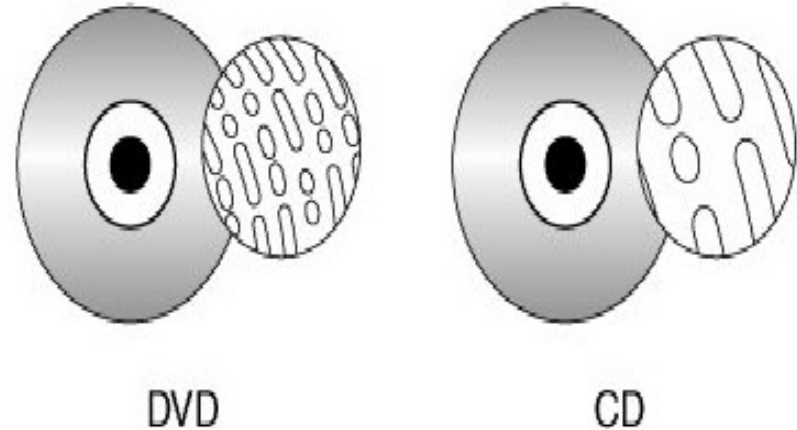
1. Low level formatting

- Low level formatting is the process of outlining the position of the tracks and sectors on the hard disk, and writing the control structures that define where the tracks and sectors are.
- This is often called a “true” formatting operation because it really creates the physical format that defines where the data is stored on the disk.
- If an LLF is done on a disk with data on it already the data is permanently erased.

2. High level formatting

- After low level formatting is complete we have a disk with tracks and sectors but nothing written on them.
- High level formatting is the process of writing the file system structures on the disk that let the disk is used for storing programs and data.
- High level formatting is done after the hard disk has been partitioned even if only one partition is to be used.

DVD Format



- Based on data capacity DVD have following three physical format:
 - Smaller pit size
 - Tighter track spacing
 - Multi layer capability

Smaller Pit Size

- DVDs have smaller pit size than CDs.
- Pits are the slight depressions or dimples on the surface of the disc that allow, the laser pickup to distinguish between the digital 1's and 0's.

Tighter Track Spacing

- DVDs also feature tighter track spacing (i.e., track pitch) between the spirals of pits.
- In order for a DVD player to read the smaller pit size and tighter track spacing of the DVD format, a different type of laser with a smaller beam of light is required.
- This is one of the major reasons why CD players cannot read DVDs, while DVD players are capable of reading Audio CDs.

Multiple Layer Capability

- DVDs may have up to 4 layers of information, with two layers on each side. To read information on the second layer" on the same side, the laser focuses deeper into the DVD and reads the pits on the second layer.
- When the laser switches from one layer to another layer, it is referred to as the "layer switch" or the "RSDL (reverse spiral dual layer)switch".
- To read information from the other side of the DVD almost all DVD players require the user to manually flip the disc.

- Based on DVD's dual-layer and double-sided options, there are four disc construction formats:
- **Single-sided, single-layered**
- **Single-sided, dual-layered**
- **Double-sided, single-layered**
- **Double-sided, dual-layered**

Blu ray disk

- The Blu-ray Disc format was developed by nine manufacturers called the “Blu-ray Disc Association”.
- These companies include Sony, Panasonic, Pioneer, Philips, Thomson, LG Electronics, Hitachi, Sharp, and Samsung Electronics.
- The idea behind this format is to use a new blue-violet laser technology to encode much more digital data compared to DVD.



 MITSUBISHI

BD-R 2x
LTH TYPE
130min/25GB



Features of blu ray disk

- It is an optical disc storage media format.
- Its main uses are high-definition video and data storage. The disc has the same dimensions as a standard DVD or CD. Uses a 405nm blue laser to read/write data.

Blu-ray vs. DVD Capacity

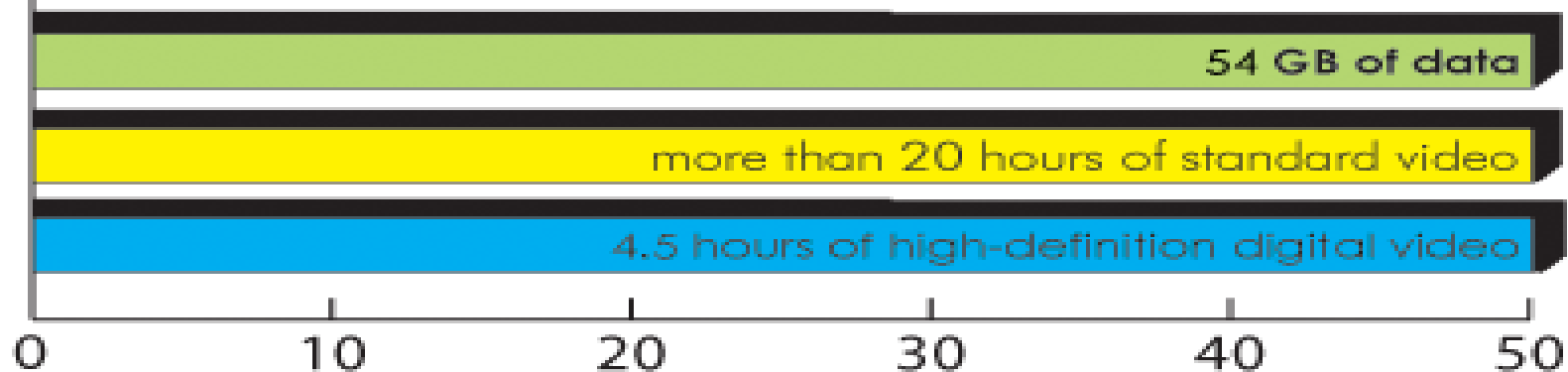
Single-layer DVD



Single-layer Blu-ray disc



Double-layer Blu-ray disc



Blue Ray Disc Formats

Blu-ray is initially designed in several different formats:

- **BD-ROM** (read-only) - for pre-recorded content
- **BD-R** (recordable) - for PC data storage
- **BD-RW** (rewritable) - for PC data storage
- **BD-RE** (rewritable) - for HDTV recording

Variations and Sizes

- A single-layer Blu-ray disc (BD) has enough storage capacity (25GB) for approximately two hours of high-definition video with audio.
- A dual-layer (50GB) BD can hold enough data for approximately four hours of HD video.
- TDK recently announced that they have created a working Blu-ray disc capable of holding 200GB of data.

DATA RATE

- For high-definition movies a much higher data rate is needed than for standard definition. Blu-ray also has a higher data transfer rate 36 Mbps than today's DVDs, which transfer at 10 Mbps.
- A Blu-ray disc can record 25 GB of material in just over an hour and a half.

COMPATIBILITY

➤ Blu-ray lasers and drives are capable of reading the various DVD formats, ensuring backward compatibility.

Laser and optics

- Blu-ray systems use a blue-violet laser operating at a wavelength of 405 nm, similar to the one used for HD DVD, to read and write data.
- Conventional DVDs and CDs use red and infrared lasers at 650 nm and 780 nm respectively.

Hard-coating technology

- In January 2004 was introduced a clear polymer coating that gives Blu-ray Discs scratch resistance.
- The coating was developed by TDK Corporation and is called "Durabis".
- It allows BDs to be cleaned safely with only a tissue.

Write Blu-ray disk specification(Nov-2014,May-2015) OR Write the difference between Blu-ray & DVD.

Parameter	Blu-Ray	DVD
Storage Capacity	25GB(Single –layer) 50GB(dual-layer)	4.7G8 (single-layer) 8.5G8 (dual-layer)
Laser wavelength	405nm (blue laser)	650nm (red laser)
Numerical aperture (NA)	0.85	0.60
Disc diameter	120mm	120mm
Disc thickness	1.2mm	1.2mm
Protection layer	0.1mm	0.6mm
Hard coating	Yes	No
Track pitch	0.32µm	0.74µm
Data transfer rate(data)	36.0Mbps(1X)	11.08Mbps(1X)
Data transfer rate (video/audio)	54.0Mbps(1.5X)	10.08Mbps(<1X)
Video resolution (max)	1920x1080 (1080p)	720x480/720x576
Video bit rate (max)	40.0Mbps	9.8Mbps (480i//480p/576i)
Video codec	MPEG-2 MPEG-4 AVC SMPTE VC- 1	MPEG-2 ----- -----
Audio codec	Linear PCM Dolby Digital Dolby Digital plus Dolby True-HD DTS Digital Surround DTS-HD	Linear PCM Dolby Digital DTS Digital Surround ----- ----- ----- -----
Interactivity	BD-J	DVD Video