Hard Disk Drive

- It is a data storage device in a computer.
- It is a secondary storage device.
- Its stored in 0 (or) 1.
- The operating system , software and most other files are stored in the HDD.
- Its invented in 1954 by IBM.
- Nowadays, HDD with3.5 inch or 5.25 inch platters in different capacities, such as 10GB, 20GB, 40GB, 80GB etc.

- **Track :**
  - The HDD is divided into number of concentric circles called tracks.
  - Circular path in sector is called track.
- **Sector :**
  - Data storage area in one track multiple divided into the multiple block is called sector.
  - Each sector can have 512 bytes of the data.
- **Cylinder:**
  - A set of corresponding tracks in all sides of a hard disk is called cylinder.
- **Storage capacity:**
  - Its having a formula shown below:
  - storage capacity=number of cylinder’s*tracks per cylinder* sector per tracks*bytes per sector.

Disk formatting

- Disk formatting is the process of preparing a data storage device such as a hard disk drive, solid-state drive, floppy disk or USB flash drive for initial use.
- Formatting a disk involves three different processes

1. Low level formatting
2. Partitioning
3. High level formatting

Low-level formatting

- The first part of the formatting process that performs basic medium preparation.
- Low-level formatting is the process of marking out cylinders and tracks for a blank hard disk, and then dividing tracks into multiple sectors.

- It is normally done by the manufactures.

Partitioning

Partitioning is the process of writing information into blocks of a storage device that allows access by an operating system.

It involves the division of the hard drive into logical volumes for data storage.

- Fdisk is a command used in DOS and windows 9x to partition a hard disk.
- Once your drive is partitioned, each partition will have to be formatted with a file system.

High-level formatting

- The third part of the process, is termed as"high-level formatting" .
- It refers to the process of generating a new file system.
- It is the process of setting up an empty file system on a disk partition or logical volume and, for PCs, installing a boot sector.

File System

- in a computer system everything is stored as files.
- The files can be data files or application files.
- Each operating system has its own way of organizing data internally in drive.
- The operating system performs this management with the help of a program called **File System**.
- It specifies how data is stored on the drive and what types of information can be attached to files—filenames, permissions, and other attributes.

Types of File system

- FAT
  - FAT versions –FAT12,FAT16, FAT32
  - (The traditional DOS file system types are FAT12 and FAT16)
- VFAT
- FAT32
- NTFS

FAT File System

- FAT stands for "File Allocation Table".
- The file allocation table is used by the operating system to locate files on a disk.
- A file may be divided into many sections and scattered around the disk due to fragmentation. FAT keeps track of all pieces of a file.
- In DOS systems, FAT is stored after boot sector.

Features of FAT File System

- Naming convention
  - FAT file system used by MS-DOS provides file name of only 8 characters long.
  - A filename can have no more than eight characters before the period and no more than three after.
  - Filenames aren't case sensitive.
  - File names can contain any character except “/ \ [] = , ^ ?a “”
  - File names should begin with alphanumeric characters.
  - File names can contain spaces and multiple periods. The characters after the last period are treated as file extension.

- FAT does not support local and folder security. A user logged on a computer locally has full access to the files and folders in FAT partitions of the computer.

- FAT provides quick access to files.

VFAT

- VFAT is an extension of the FAT file system.
- It was introduced with Windows 95.
- VFAT maintains backward compatibility with FAT
- VFAT filenames can contain up to 255 characters, spaces, and multiple periods.
- it's not considered case sensitive.

VFAT

- When you create a long filename (longer than 8.3) with VFAT, the file system actually creates two different filenames. One is the actual long filename. This name is visible to Windows 95, Windows 98, and Windows NT (4.0 and later).
- The second filename is called an MS-DOS® alias. An MS-DOS alias is an abbreviated form of the long filename. The file system creates the MS-DOS alias by taking the first six characters of the long filename (not counting spaces), followed by the tilde [~] and a numeric trailer. For example, the filename Brien's Document.txt would have an alias of BRIEN'~1.txt.

FAT32 File System

- FAT32 is an advanced version of FAT file system.
- It is actually an extension of FAT and VFAT
- It can be used on drives from 512 MB to 2TB in size.
- Compatible with operating systems other than Windows 2000.

NTFS File System

- NTFS stands for "New Technology File System".
- Windows 2000 professional fully supports NTFS.

- **Features of NTFS File System**

- Naming Conventions
  - File names can be up to 255 characters
  - File names can contain most characters except “ / \ * | :
  - File names are not case sensitive

- Security
  - NTFS provides file and folder security. Files and folders are safer than FAT. Security is maintained by assigning NTFS permissions to files and folders. Security is maintained at the local level and the network level. The permissions can be assigned to individual files and folders. Each file or folder in an NTFS partition has an Access Control List. It contains the users and group security identifier (SID) and the privileges granted to them.
- Partition Size
  - The NTFS partition and file sizes are much bigger than FAT partitions and files. The maximum size of an NTFS partition or file can be 16 Exabyte. The file size can be in the range of 4GB to 64GB.

- **File compression**
  - NTFS provides file compression of as much as 50%.
- **High reliability**
  - NTFS is highly reliable. It is recoverable file system. It uses transaction logs to update the file and folders logs automatically. The system also has a great amount of fault tolerance. It means that if transaction fails due to power or system failure, the logged transactions are used to recover the data.
- **Bad cluster Mapping**
  - NTFS supports bad-cluster mapping. It means that file system detects bad clusters or areas of disk with errors. If there is any data in those clusters, it is retrieved and stored on another area. The bad clusters are marked to prevent data storage in those areas in future.

NTFS disadvantages

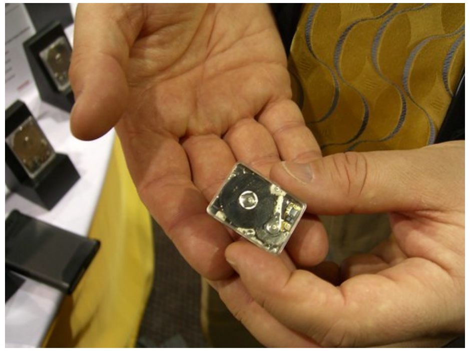
- NTFS volumes can’t be accessed by MS-DOS, Win 9x
- Slower performance for very small volumes (under 400 MB)

HARD DISK DRIVE

Definitions

- A hard disk drive (HDD) is a **non-volatile computer storage device** containing magnetic disks or platters rotating at high speeds.
- It is a secondary storage device used to **store data permanently**, random access memory (RAM) being the primary memory device.
- Non-volatile means **data is retained** when the computer is turned off.
- A hard disk drive is also known as a **hard drive**.

1. Which is the world smallest Hard Disk Drive?



Toshiba gets the credit for creating the world's smallest hard drive.
At just **.85 inches**, it is about the size of a **postage stamp** or a quarter, and weighs in at just two grams.
It even made its way into the **Guinness Book of World Records**

2. Can you guess the spinning speed of Disk Platter in HDD

ANSWER

5,400 or 7,200 times per minute, depending on the hard drive

3. Which is the Largest Hard Disk Drive?

ANSWER

Samsung unveils massive 16TB SSD built with new 3D NAND

4. Which is the first hard drive ever?

ANSWER

The **350 Disk Storage Unit** was released in **1956 by IBM**. It had a capacity of **3.75MB** and was the size of a refrigerator.

ANSWER

5. Can you guess the Cost of First ever HDD

ANSWER

it cost around $35’000

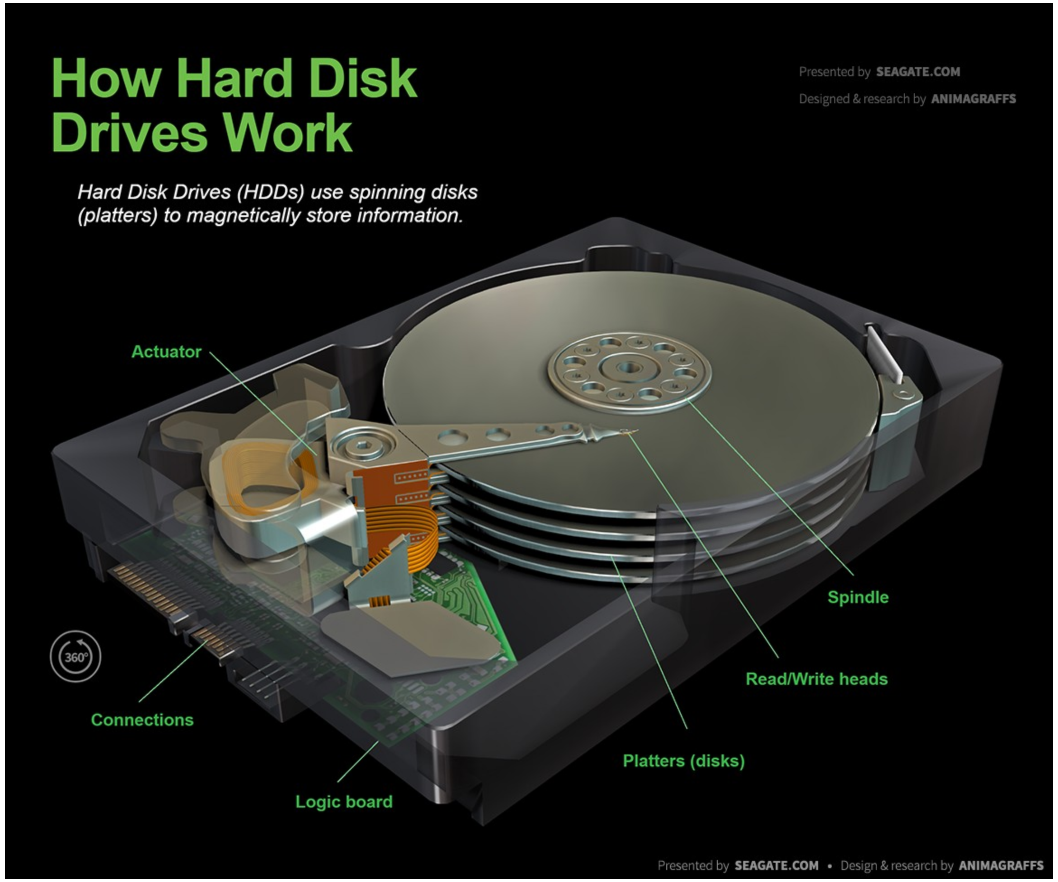
26,35,325.00

26 LAKHS

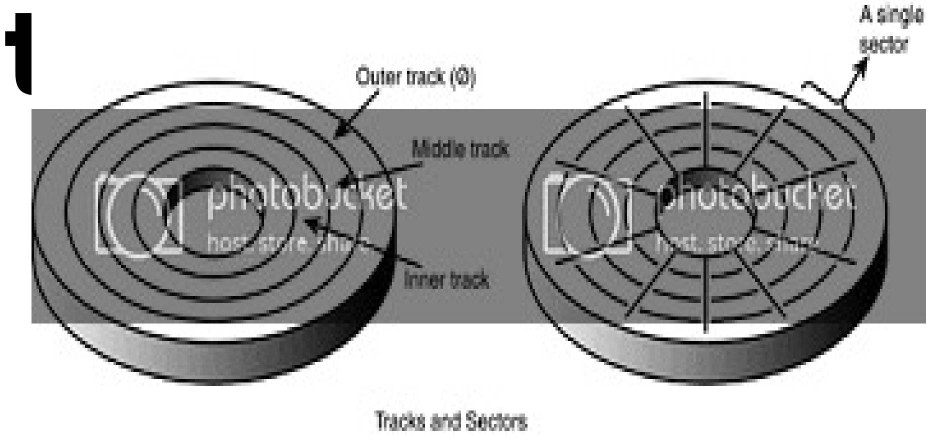
DISK PLATTER

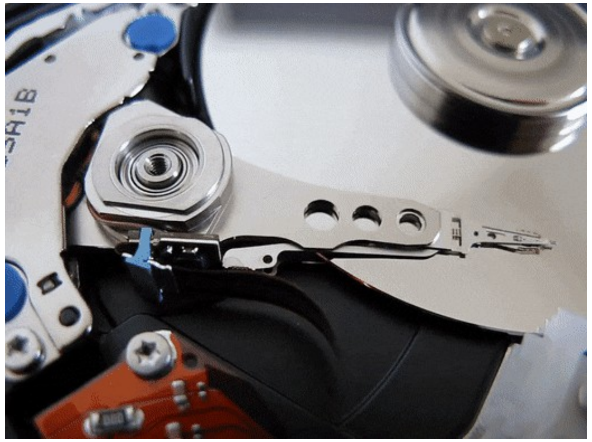
Definitions

- A hard drive fits inside a computer case and is firmly attached with the use of braces and screws to prevent it from being jarred as it spins.
- Typically it spins at 5,400 to 15,000 RPM. The disk moves at an accelerated rate, allowing data to be accessed immediately.
- Most hard drives operate on high speed interfaces using serial ATA (SATA) or serial attached technology.


How Hard Disk Drives Work
Hard Disk Drives (HDDs) use spinning disks (platters) to magnetically store information.
Presented by SEAGATE.COM
Designed & research by ANIMAGRAFFS
Actuator
Spindle
Read/Write heads
Platters (disks)
Connections
Logic board
360°
Presented by SEAGATE.COM • Design & research by ANIMAGRAFFS

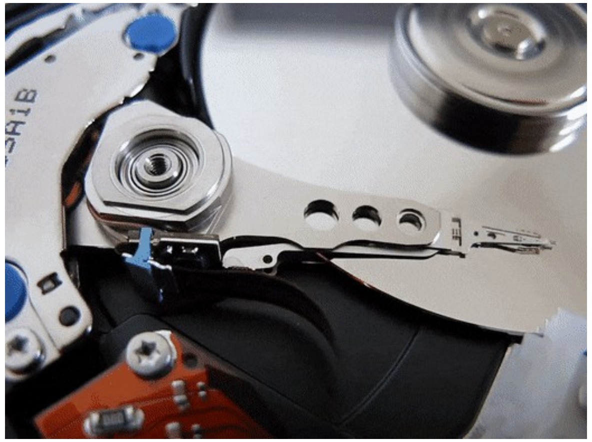
HDD - Operat





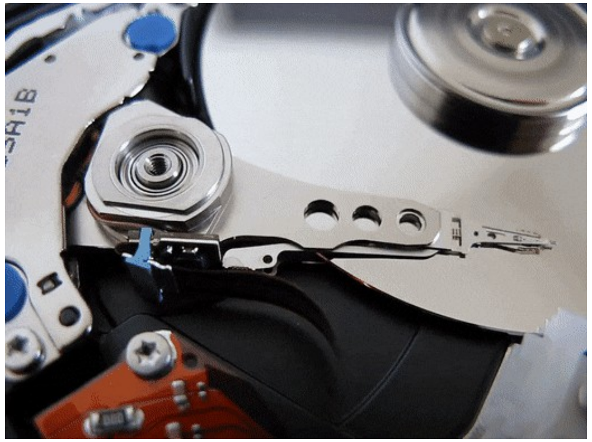
- The basic physical construction of a hard disk drive consists of spinning disks with heads that move over the disks and store data in tracks and sectors.
- The heads read and write data in concentric rings called *tracks*, which are divided into segments called *sectors*, which typically store 512 bytes each.

HDD- Operation



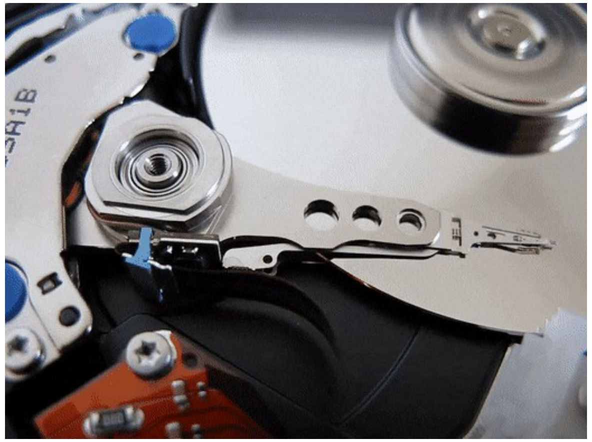
- Hard disk drives usually have multiple disks, called platters, that are stacked on top of each other and spin in unison, each with two sides on which the drive stores data.
- Most drives have two or three platters, resulting in four or six sides, but some PC hard disks have up to 12 platters and 24 sides with 24 heads to read them

HDD - Operati



- The identically aligned tracks on each side of every platter together make up a cylinder.
- A hard disk drive usually has one head per platter side, with all the heads mounted on a common carrier device or rack.
- The heads move radially across the disk in unison; they can't move independently because they are mounted on the same carrier or rack, called an actuator.

HDD - Operati



- Originally, most hard disks spun at **3,600rpm**—approximately 10 times faster than a floppy disk drive.
- For many years, 3,600rpm was pretty much a constant among hard drives. Now, however, most drives spin even faster.
- Although speeds can vary, modern drives typically spin the platters at either 4,200rpm; 5,400rpm; 7,200rpm; 10,000rpm; or 15,000rpm. Most standard-issue drives found in PCs today spin at 5,400rpm, with high performance models spinning at **7,200rpm**.

HDD - Operation

- High rotational speeds combined with a fast head-positioning mechanism and more sectors per track are what make one hard disk faster overall than another.
- The heads in most hard disk drives do not (and should not!) touch the platters during normal operation.

HDD – Operation (HEAD CRASH)

- However, on most drives, the heads do rest on the platters when the drive is powered off. In most drives, when the drive is powered off, the heads move to the innermost cylinder, where they land on the platter surface. This is referred to as **contact start stop (CSS) design**.
- When the drive is powered on, the heads slide on the platter surface as they spin up, until a very thin cushion of air builds up between the heads and platter surface, causing the heads to lift off and remain suspended a short distance above or below the platter.
- If the air cushion is disturbed by a particle of dust or a shock, the head can come into contact with the platter while it is spinning at full speed. When contact with the spinning platters is forceful enough to do damage, the event is called a ***head crash***.

HDD - Operations

- The result of a head crash can be anything from a few lost bytes of data to a completely ruined drive.
- Most drives have special lubricants on the platters and hardened surfaces that can withstand the daily "takeoffs and landings" as well as more severe abuse.

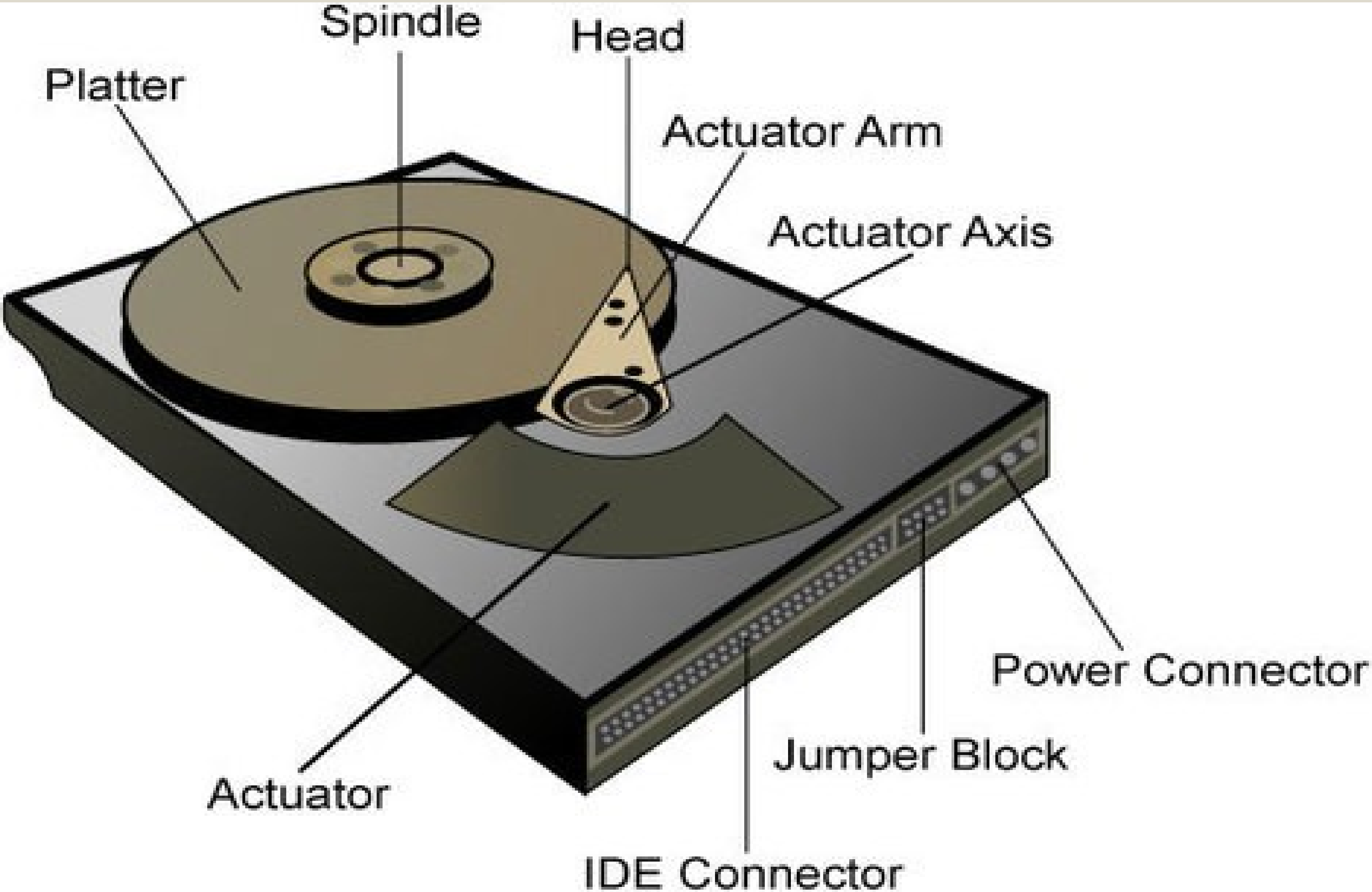
Hard **D**isk **D**rive Components

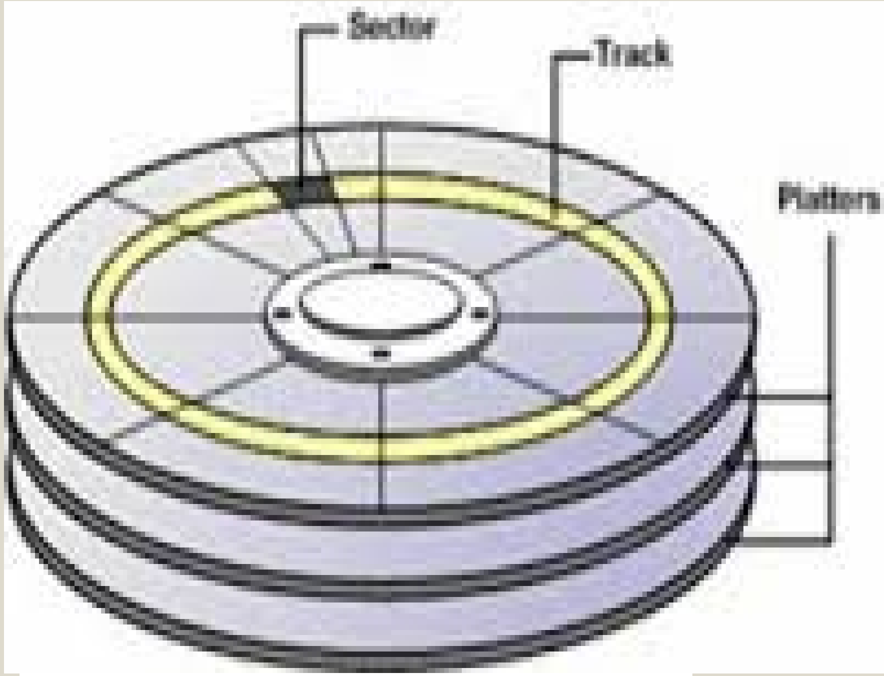
HDD

Basic components of a hard drive

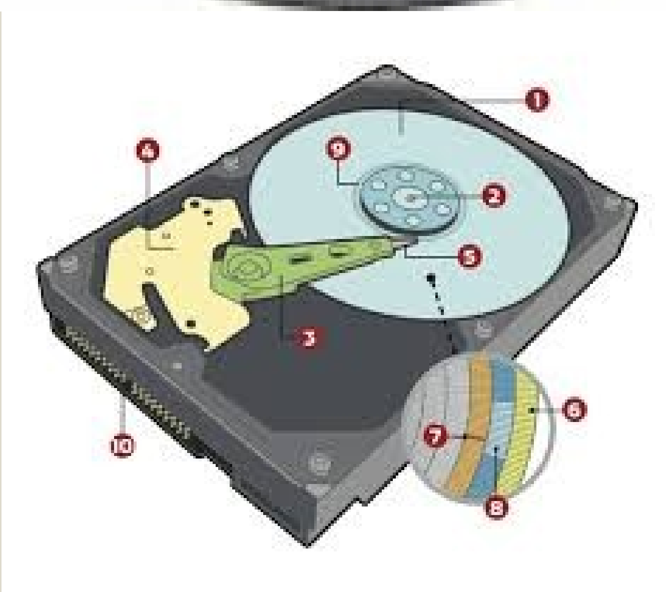
- Disk platters
- Read/write heads
- Head actuator mechanisms
- Spindle motor
- Logic board
- Cables & connectors
- Air Filter and Bezel

Components


Spindle
Head
Platter
Actuator Arm
Actuator Axis
Power Connector
Jumper Block
Actuator
IDE Connector


Sector
Track
Platters


Download from
Dreamstime.com


1
4
9
2
5
3
6
7
10
8

Hard Disk Platters

- Hard disk drive contains a number of disk platters.
- Information is magnetically recorded here.
- Platter size is called the form – factor of the hard drive.
- Hard disk drive size is referred by the platter’s diameter.
- 5 ¼ inch (actually 5.12 inch)
- 3 ½ inch (actually 3.74 inch)
- 2 ½ inch
- 1 1/8 inch
- 1 1/3 inch

Hard Disk Platters

- Hard disks have been a number of different form factors over the years
- 3 1/2 inch drives are the most popular for desktop & some portables
- Max number of platters in a 3 1/2 inch drive is 11.
- 1 1/3 inch drives are very small, almost the wrist watch size.
- Number of platters in one HDD can be as low as 1 and as high as 10 or more, but 2 or 3 are most common.

Hard Disk Platters

- Traditionally made from aluminum alloy
  - Because of their strength and light weight
- Being a metal, they expand and contract with the change in the temperature.
- This led the drive manufacturer to use glass or glass ceramic.
- Desire for higher density has led to the use of platters made of glass (glass ceramic composite)
  - Glass platters offer greater rigidity & more stable thermally

Hard Disk Platters

- No matter what type of platter is used, the platters are covered with a thin layer of magnetically retentive substance (called the medium) on which magnetic information is stored.
  - Oxide media
  - Thin-film media

Oxide media

- Made of various compounds, oxide being the primary active ingredient
- Put on the disk like syrup, coating the entire disk
- Coating is approx 30 millionths of an inch and is made smooth
- Platters appear to look brownish or amber
- Very sensitive to head-crash during movement of operation
- Very few drives use this technology anymore.

Thin-film media

- **Thinner, harder & more perfectly formed than oxide media**
- **Thickness of thin film media is 1-4 millionth of an inch.**
- **The thinness of the coating allows the HDD head to be positioned very close to the disk surface, which allows very high density recording on the surface.**
- **Coating is put on the platter using an electroplating mechanism, similar to that of putting chrome plating on the bumper of the car.**
- **Looks silver like the surface of a mirror**

Thin-film media

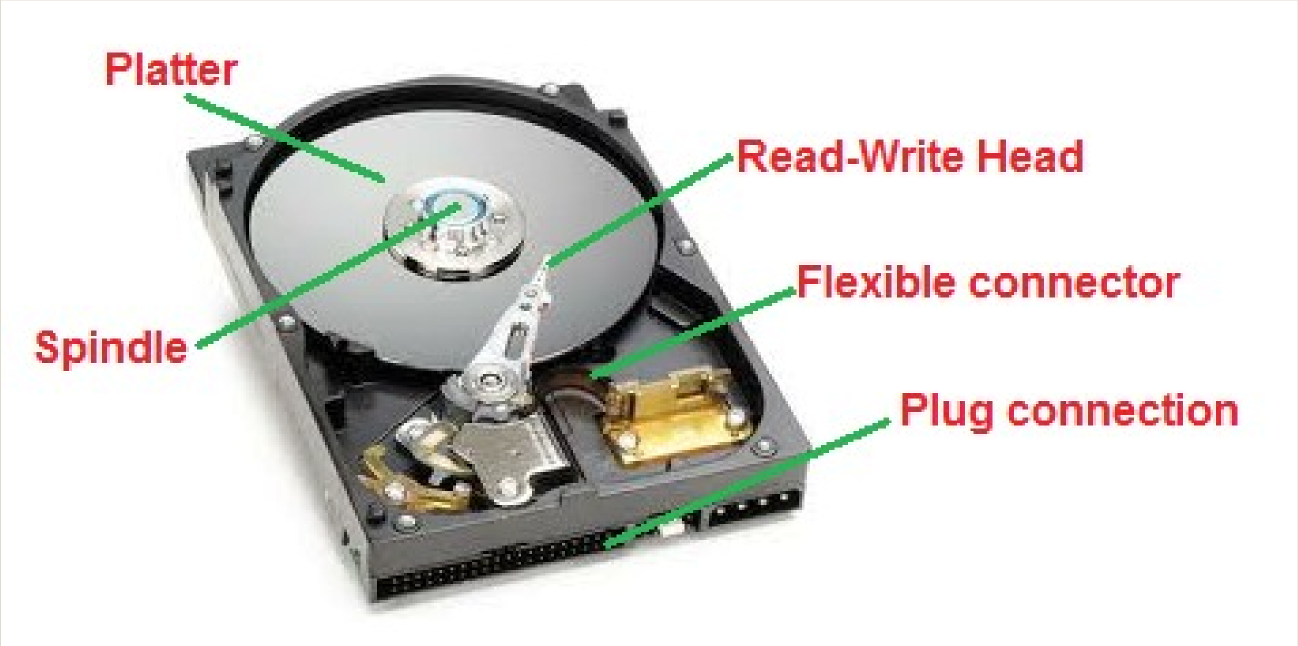
- **The thin film media is created on the platter surface using two different process**
  - **Plating process**
  - **Sputtering process**

Plating and Sputtering

- **<u>Plating</u> is produced using electroplating process.**
- **The Platter substrate is immersed in different chemicals to coat the platter surface with a very uniform 2 to 3 micro inch thick cobalt alloy coating.**
- **<u>Sputtering</u> provides thinnest, hardest and finest media surface.**
- **The platter substrate is first coated with a layer of nickel phosphorus and then on this surface cobalt alloy material is deposited using sputtering**

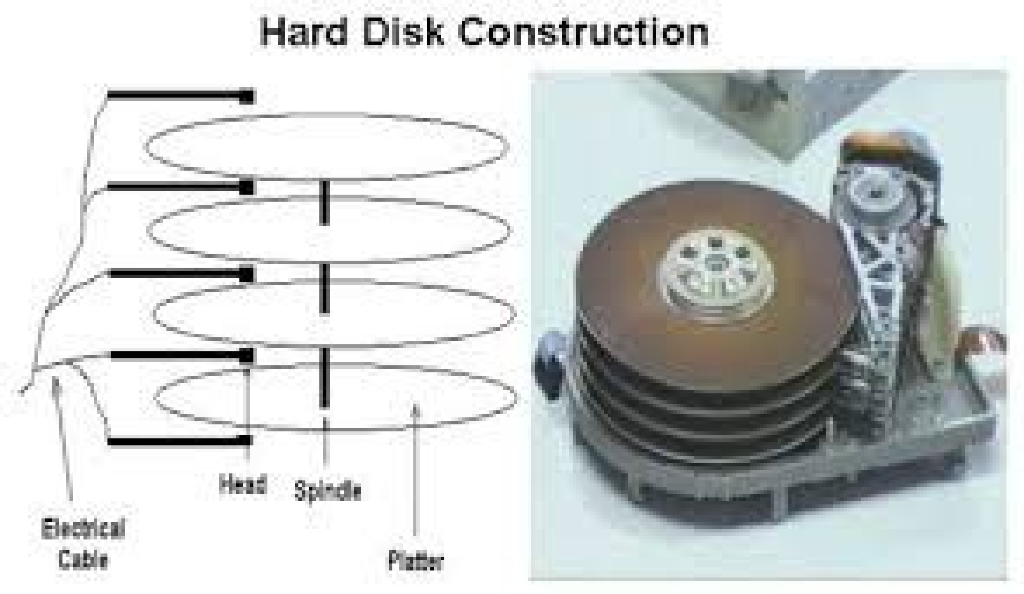
Read/Write Heads

- Read / Write head is used to **write any information** on the disk surface and to **read the written data back without any data loss.**
- A hard disk has **one read/write head** for each side of the platter.



Read/Write Heads

- **Six read/write head will be used to read the two (top & bottom) sides of each platter.**
- **All the heads are connected together and moved in and out on a single movement mechanism. i.e. one cannot move different head in different order.**



Read/Write Heads

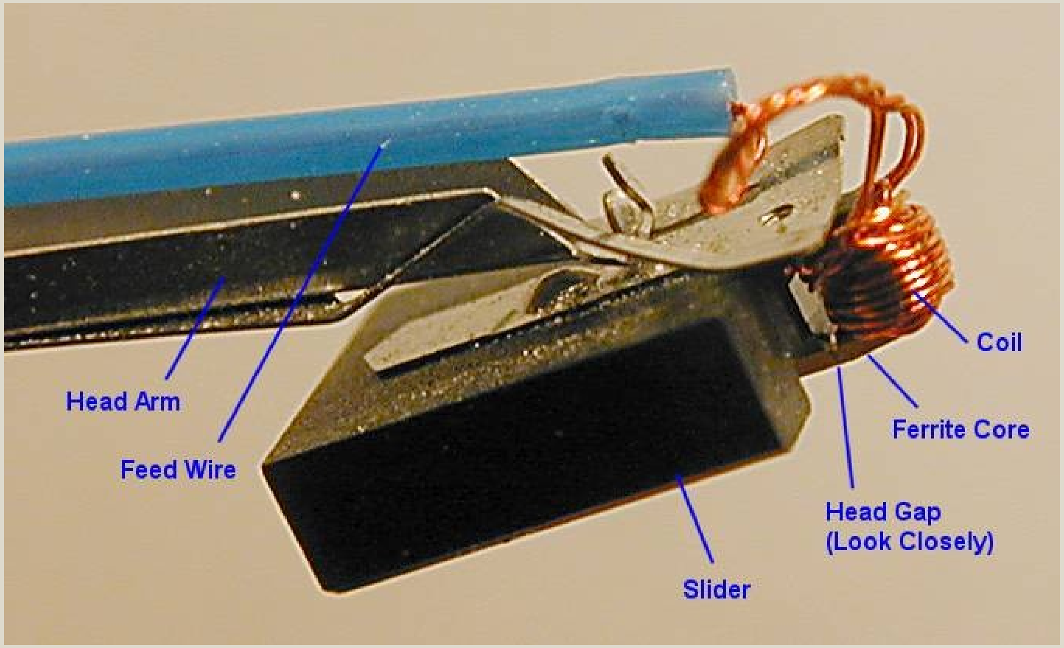
- At rest, Read/Write head will be in direct contact with the disk surface.
- Due to very high rotation speed, air pressure developed and this helps the read/write head to lifts them above from the disk surface.
- 3 to 10 millionth of inch above from the disk surface.
- Since the disk is rotating at 3600 to 7200 rpm, even a small dust particle may seem like a mountain.
- It may result in scratch at the disk surface and may loss the data.

Read/Write Heads

- The hard disk is manufactured and serviced in a room known as "class 100 clean room"
  - Room where less than 100 dust particles of 19.7 μ inch, when one cubic air foot is checked.
- Four types of read/write head designs:
  - Ferrite
  - Metal-In-Cap
  - Thin-film
  - Magneto-resistive

Ferrite

- Developed by **IBM**.
- Made of **iron-oxide core** wrapped by passing a magnetic field near them.
- Heads were **large & heavy.**
- Required a **much higher floating height than today.**



Ferrite

- **To write any information using the head, the coil is energized, which produces magnetic field on the disk surface.**

- **To read the information, the head is passed over the disk surface and the induced current generated in the coil is used to read the data.**

Metal-In-Gap

- **Have a layer of magnetic alloy, which increased the magnetization capability & allowed the heads to write at higher densities.**
- **Enhanced version of the ferrite heads**
- **Virtually obsolete.**

Thin Film

- Very small and light weight heads.
- Can be used as close as 2 µ inch or less to the disk surface.
- Created through a photolithographic process
- Manufactured in the same manner as a semiconductor
- Very narrow & controlled head gap that is created by sputtering (a process of spreading material very thinly on a surface) a hard aluminum material.
- Initially, it was very costly.

Thin Film

- **The material completely encloses the gap & protects the area.**
- **Head is very light & can float much closer to the platters than previous technologies.**
- **Writes at much higher densities.**

Magneto-Resistive

- Latest in technology & highest performance available
- As areal density increases (technology growth rate indicator), TF and MIG will disappear
- Relies on the fact that the resistance of a conductor changes slightly when an external magnetic field is present
- Two heads in one - MR heads do not write
- They are sensors for reading

Head Actuator Mechanism

- A drive using a stepper motor is much less reliable than one using a voice coil
- Floppy drives use a stepper motor to position their heads
- Accuracy of the stepper is suited to a floppy drive, because track densities usually lower
- Moves the heads across the disk & positions them accurately above the desired cylinder
- Two basic categories
  - Stepper Motor actuators
  - Voice coil actuators

Stepper Motors

- An electrical motor that can step or move from position to position, with mechanical dents or click-stop positions.
- Can only stop at predetermined spots
- Motors sealed outside of the head disk assemble, although the spindle of the motor penetrates the head disk assembly through a sealed hole
- Variety of problems
  - Temperature, largest
  - Can’t compensate for changes in the track movement due to expansion & contraction

Voice Coil

- Used in almost all hard drives today
- Uses feedback signal from drive to accurately determine head positions & adjust them
- Works by pure electromagnetic force
- Similar to construction of a typical audio speaker
- Audio speaker uses a stationary magnet surrounded by a voice coil which is connected to the speakers paper cone
- When the coil is energized, it moves & produces sound from the cone
- In a typical hard disk, the electromagnetic coil is attached to the end of the head rack & placed near a stationary magnet

Voice Coil

- There is no physical contact between the coil & the magnet
- It moves by electromagnetic force
- This force moves the head rack.
- Use a servo-mechanism to move to the desired position on the disk
  - Stepper motors move to predetermined spots
- Not affected by temperature
- Automatic head parking
  - Heads are positioned by magnetic force, so when power removed, mag field disappears & heads stop

Air filters

- Most have two
  - Recirculating filter - filters small particles scraped off the platers during takeoffs & landings
  - Breather filter - allows for pressure equalization
    - Heads don’t float if pressure not right
- Drives are sensitive to temperature
- If the drive has been very cold, let it warm up before powering on. Watch humidity

Spindle motor

- Motor that spins the platters
- Connected directly to the drive

Logic Boards

- Mounted on the hard drive
- Contain electronics that control the drive's spindle & head actuator systems & present the data to the controller

Cables & Connectors

- Several connectors for interfacing to the computer, receiving power & sometimes grounding to the system chassis
- Three types
  - Interface connectors
  - Power connectors
  - Option ground connector (green wire)

Power Connector

- Usually same 4-pin connector type that is used in a floppy disk drive
- Same power-supply connector plugs into it
- Most use both 5 & 12 volt power
  - Red, yellow, 2 black with keyed white end

INSTALLING A HDD

- Turn off the power and remove the power cable from the socket. Remove the system unit cover.
- Install the drive's controller card as you would any other card. Be sure to secure the card into the expansion slot by replacing the screw that holds the card to the back of the chassis.
- Remove the bay's blanking plate if you are installing a drive that has a bezel.

INSTALLING A HDD

- Check the settings of jumpers on the drive to ensure that, it is properly setup. Check the position of the drive select jumper, master/slave jumper etc.
- Attach the mounting rails to the sides of the drive, if appropriate, then slide it into the drive bay.
- Attach the data / control cable to the controller card, and then attach it to the back of the drive. Be sure the striped edge (edge with red color) ..

INSTALLING A HDD

- .. Of the ribbon cable goes to the side of the connector where pin 1 is. Attach the power supply cable.
- Insert and tighten the mounting screws. Make sure that they do not dig into the casing of the HDD.
- Connect the HDD led indicator connector to the appropriate pins on your controller card or HDD, if you wish to use the LED to note hard drive activity.

INSTALLING A HDD

- Power up the system. Update the CMOS RAM configuration on AT machines. You must boot from a diskette if you have inserted a new unformatted C drive. Low – level format the new drive if necessary.
- If everything works fine then replace the system unit cover.
- Partition the new drive using FDISK and then DOS FORMAT it.

FAT

- A **file allocation table** (**FAT**) is a **file** system developed for hard drives that originally used 12 or 16 bits for each cluster entry into the **file allocation table**. It is used by the operating system (OS) to manage **files** on hard drives and other **computer**systems.

FAT function

- A **file allocation table** (**FAT**) is a **table** that an operating system maintains on a hard disk that provides a map of the clusters (the basic units of logical storage on a hard disk) that a **file** has been stored in.

TYPES of FAT

- **Today, later versions of Microsoft Windows, such as Windows XP, Vista, 7, and 10 are using NTFS and not FAT.**
- FAT8. The oldest FAT, FAT8 was used on 8-inch floppies with the 8086 processor.
- FAT12. A File Allocation Table that uses 12-bit binary system that was derived from FAT8. ...
- FAT16. ...
- FAT32.

VFAT

- Virtual File Allocation Table (VFAT) is the part of the Windows 95 and later operating system that handles long file names, which otherwise could not be handled by the original file allocation table file allocation table (FAT) programming.

VFAT and log file names

- When you create a long filename (longer than 8.3) with VFAT, the file system actually creates **two different filenames**. One is the actual long filename. This name is visible to Windows 95, Windows 98, and Windows NT (4.0 and later). The second filename is called an MS-DOS® alias.

VFAT and log file names

- An MS-DOS alias is an abbreviated form of the long filename. The file system creates the MS-DOS alias by taking the first six characters of the long filename (not counting spaces), followed by the tilde [~] and a numeric trailer. For example, the filename Brien's Document.txt would have an alias of BRIEN'~1.txt.

FAT 32

- **FAT32** is the older of the two drive formats. **FAT32** is the most common version of the FAT (**File** Allocation Table) **file system** created back in 1977 by Microsoft. It eventually found its way on the IBM PC's PC-DOS in 1981, and carried over to MS-DOS when that became a standalone product.

NTFS

- **NTFS** (NT **file system**; sometimes New Technology **File System**) is the **file system**that the Windows NT operating system uses for storing and retrieving files on a hard**disk**. **NTFS** is the Windows NT equivalent of the Windows 95 file allocation table (FAT) and the OS/2 High Performance **File System** (HPFS).

HDD FEATURES

Form factor
Storage capacity
Disk geometry
Interleave
Skew
Disk geometry translation

FORM FACTOR

- It is a basic unit of measurement of the size of the drive.
- Drives with platter width of 5.25 inch & 3.5 available.
- The original 5.25 inch drive is called full height drive.
    - Other sizes of 5.25 inch drives are made by different manufactures.
    - 1 inch , .75 inch and .6 inch height 3.5 inch drives are commonly used.
    - Smaller form factors like 2.5 inch, 1.75 inch, 1.3 inch drives are commonly used and popular .

Storage capacity

- HDD capacity can be expressed in 4 different ways
  - Unformatted storage capacity in millions of bytes
  - Formatted storage capacity in millions of bytes
  - Unformatted storage capacity in megabytes
  - Formatted storage capacity in megabytes.

Storage capacity

- Example;
- 1024 cylinder, 16 heads, 36 sectors and 512 bytes per sector.
- 1024 X 16 X 36 X 512 = 301, 989, 888 bytes
- Equivalent to 288 MB
  - Dividing 301,989,888 it twice with 1024.

Disk Geometry

- To arrange the data properly on the disk surface, data is divided into
  - Heads / Side
  - Tracks
  - Sectors
  - Cylinders etc.

Computer stores information on some specific track and sector. The value of track, sector, cylinder information are recorded in FAT.

Sides or Heads

- A HDD may contain several heads / sides
- Data can be written on any side or head.
- If a HDD has 3 disk platter, then it may have 3 X 2 = 6 heads / sides.
- Each side have separate read / write head to do its duty. All these heads are connected to a single head rack which makes them move as an unit.
- Heads don not require cleaning or any other maintenance. Head number starts form 0 and followed it with 1 and so on.

Track

- Each side of the hard disk drives platter's surface is divided into concentric circles called tracks.
- Tracks are not visible marks on the disk surface.
- These are magnetic information written during the formatting of the HDD.
- The outermost track number is 0 and the next track is 1, next track is 2 and so on.
- Number of tracks on hard disk may ranges from 300 to 3000.

Cylinder

- On a hard disk drive which has more than one platter, same tracks of different platters form an imaginary cylinder like structure.

- Data are normally stored in cylinder. First all the tracks of same cylinder is written, once a cylinder becomes full the read/ write head moves to the next cylinder and so on.

- Cylinder basis recording is done to avoid more read/ write movement and speeds up the time required for data read and write operation.

Sectors

- Normally a track can store more than 5000 bytes of data.
- To store less than 5000 bytes, the entire track will be wasted.
- This led to dividing the entire track into different smaller segments known as sectors.
- 17 to 100 or more sectors per track are very common in HDD.
- Number of sectors may change from manufacture to manufacture.
- Single sector can store 512 bytes of data.

Sectors - Calculation

- Let HDD has 6 sides, 1024 tracks and 37 sectors per track.
- Total sectors = total sides X total tracks per side X total sectors per track
- Total sectors = 6 X 1024 X 37
- Total sectors = 227,328
- Total storage capacity = 227,328 X 512
- = 116,391,936 bytes or 116.4MB

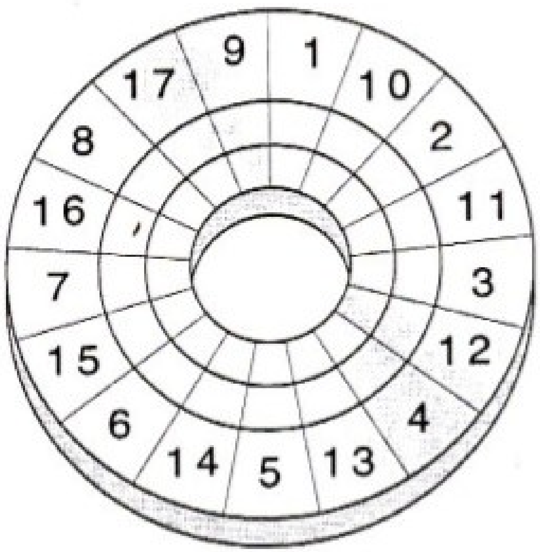
INTERLEAVE

- Numbering the sectors out of order with leaving a gap of one or more sectors in the sector numbering is called interleaving.

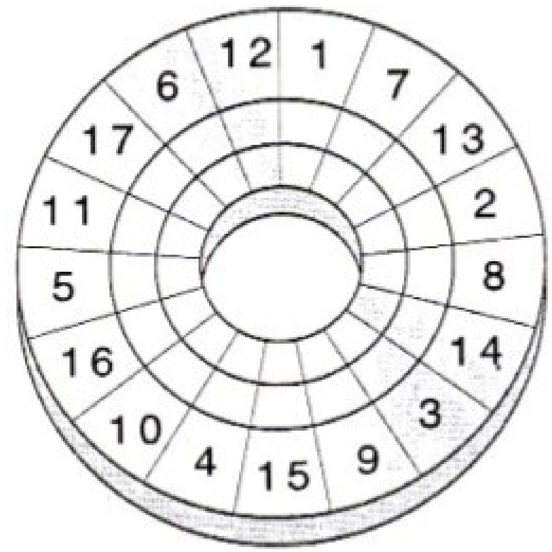
- Depending on the speed of the system and hard disk drive , one can follow 1:2 or 1:3 or any other interleave scheme.

- An interleave of 1:2 means that the next serially numbered sectored is 2 sectors away from the current sector. Correct interleave depends on the system on which the hard disk drive is being used and the controller being used to connect the drive to the system.

Interleave factor



1:2 Interleave



1:3 Interleave

INTERLEAVE

- Currently the interleave is not an issue as most computers support 1:1 interleave that is no interleave.

- All the IDE and SCSI drive are pre formatted with 1:1 interleave in the factory and most of them do not allow a change of the setting.

- To change the interleave of other drives, one would require some low level format program.

SKEW

- HEAD SKEW
- CYLINDER SKEW
- Zone bit recording

HEAD SKEW

- HDD first reads information on the cylinder 0, Head 0, Sector 1. Next, it reads all the information on the remaining sectors on the same cylinder, until the last sector is reached.

- Once the last sector of the cylinder is reached, the drive will have two options, one is to read the data from the next cylinder or read the data from the same cylinder but under the same head.

- To read the data from the next cylinder, the drive will have to move the read/write head to the next position, whereas to read data under the next head, only the selected head need to be switched.

HEAD SKEW

- Switching the head is much more faster then moving the head to the next cylinder.

- Head skewing is the change or offset in the sector numbering in tracks under adjacent heads of the same cylinder. This head skewing takes care of the delay incurred in head switching when data is read continuous from one head to the next head.

- Head skewing improves the drive performance of the computer.

CYLINDER SKEW

- Moving of head from one cylinder to other takes more time than the time required for the head switching. Because of this the cylinder skew value is always larger than the head skew value.

ZONE BIT RECORDING

- Zone bit recording is used by the current high capacity IDE and SCSI hard disk drives to store more number of sectors in the outer tracks compared to the number of sectors in the inner track.
- The complete surface of Hard disk platter is divided into different zones, most of the drive has 10 or more than 10 zones.
- Each zone will have a fixed number of sectors per track. The outermost zone will have maximum number of sectors per track and the inner most zone have least.