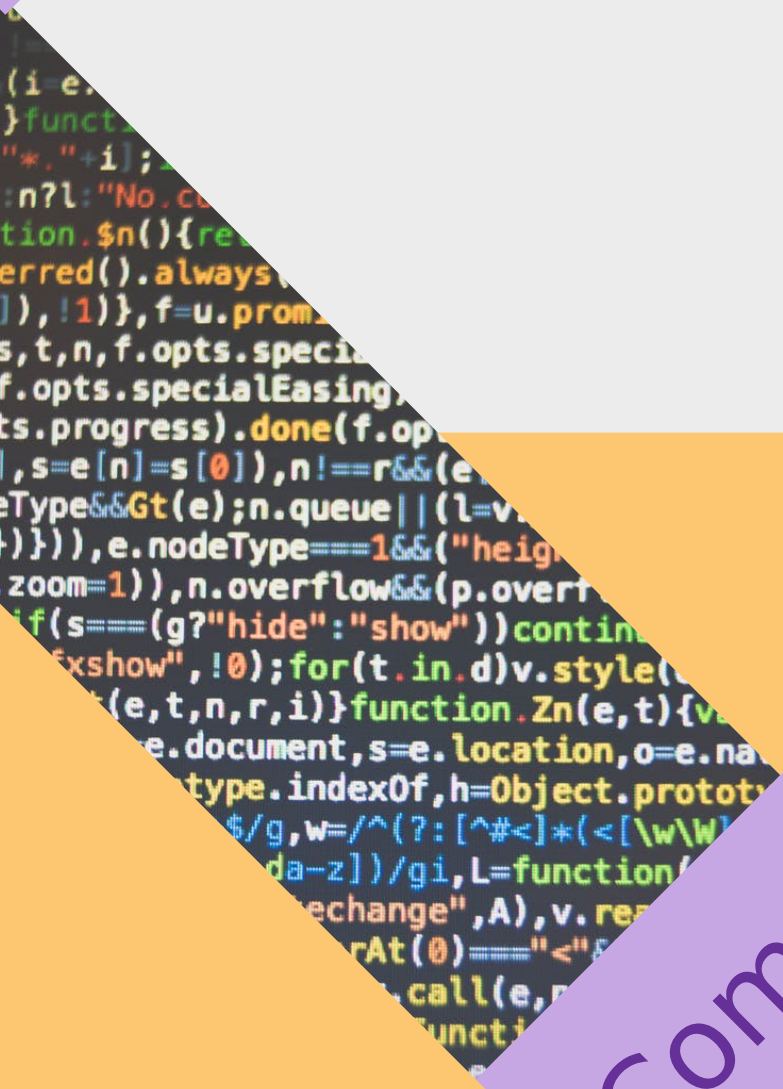
Curs 2020-2021



Computer Systems
External Hardware

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Contents

1 Hard Disk

A Hard Disk Drive is a data storage device no volatile which normally uses a magnètic record system. That system uses one or more platters joined by an axis. All that elements are inside a sealed box. Nowadays , as it will be seen, the SSD (Solid State Drive) is used for its benefits. Hard disk is considered a peripheral since it doesn't belong to the Von Neummann architecture.

1.1 Physical Specifications

- Physical Format. It would be possible to talk about hard disk for personal computer and laptops:
  - Personal computers: the Standard size of the hard disk is 3.5"
  - In laptops, the format is 2.5" but there are smaller-size hard disks, as it could be 1.8" and some smaller ones.
- Capacity: nowadays, the hard disk capacity is measured in GB or TB.
- Data transfer rate: it means that the hard disks' read and write speed. It is measured in MB/s. It can be divided into internal and external data transfer rate:
  - Internal Transfer Rate: it is also known as Sustained Transfer rate and normally it is lower than the external transfer rate. This is a more predictable measurement, sustained performance gives an idea of the average speed a drive will run over a longer period of time. It mainly depends on the hard disk rotational speed. Otherwise, the maximun rate internal transfer is the highest speed the drive can run for a short period of time. It should bear in mind that SSD hard disks don't have mechanical part, that is one reason to considerate that SSD will be faster than magnetic hard disks. On the other hand, external part of the platter is faster to read or write in magnetic disks. Considering that magnetic hard disks are filled from external part to internal, it could be said that magnetic hard-disks get slower as they fill.
  - External Transfer Rate: it is the transfer rate produced by system bus and hard disk buffer. It is associated with hard disk interface type and the cache's size. In a SATA, a disk can be up to 600 MB/s or SCSI 320 MB/s.

1.2 Types of interfaces

The kind of technology or interface used to connect hard disks to the motherboard is very important because it defines the speed of the data transfer.

1.2.1 Ide interface

Ide interface, also called PATA, Ultra Ata or Ultra DMA, is an acronym for Integrated Drive Electronics, the connector used since the SATA appeared and the most used, because it is a Standard type of connection for devices in a computer. Ide refers to the cables and ports to connect hard devices but also Optical drives.

That interface transmits data in parallel way, that is to say, it transmits bit group each pulse. The IDE disk is distributed into channels and it uses ribbon cable. Each cable is able to connect 2 devices because it has 2 channels. In each channel the devices has a role:

- Master: the devices controls the bus and takes precedence over the other operating system boot.

- Slave.

The connection used by the devices has to be configured. The configuration is set enabling the suitable connection in a jumper. That jumper is on the back of each device. There are some options:

- Master/slave (MA/SL): Set if the device will be the master or the slave in the channel
- Cable Select (CS): the decision of master or slave is given by the position on the cable.

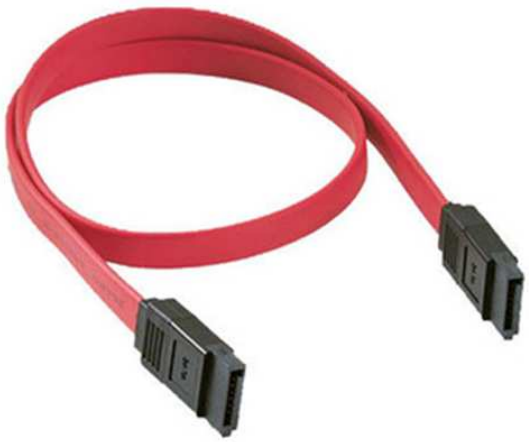
The cable to connect the devices can be seen in the last pictures. There are cables with 32 wires for floppy devices, 40 wires and cables with 80 wires. The PATA cables can have a data transfer speed from 16 or 33 MB/s to 133 or 133 MB/s depending on the cable.

1.2.2 Sata interface

The difference between SATA interface and PATA interface is that SATA interface transmits the data in serial way. That is mostly used nowadays and PATA has got out of date. The problem with PATA comes from the interferences in high speed of transmissions. In high speed, the interferences increases and it is better to transmit in serial way. So SATA transmits groups of bits in serial way.

SATA interface, not only reduces the dimensions of the cable improving the ventilation inside of the box, but, it also improves the speed, reaching 600 MB/s nowadays in SATA 3.0 version.

It is possible to see the cable in the following pictures. It has 7 pins, 4 for data and 3 for ground connection.



1.2.3 SCSI Interface

This connection is used when the SATA interface doesn't offer enough performance. This connectors reaches 20 GB/s.

1.2.4 External hard disk interface

Nowadays storing data is very common, so there are external hard disks. The most used connectors for external disks are:

- USB: it is the most used.
- FireWire: it is faster than USB but not too used
- Serial ATA (eSATA): this external connector offers better speed than the previous ones. The cable should be lower than 2 meters.

2 Magnetic hard disk

It is necessary some device in order to store information in a permanent way. Magnetic devices takes advantage of the magnetic properties in order to store the information in that way. There are some benefits and drawbacks:

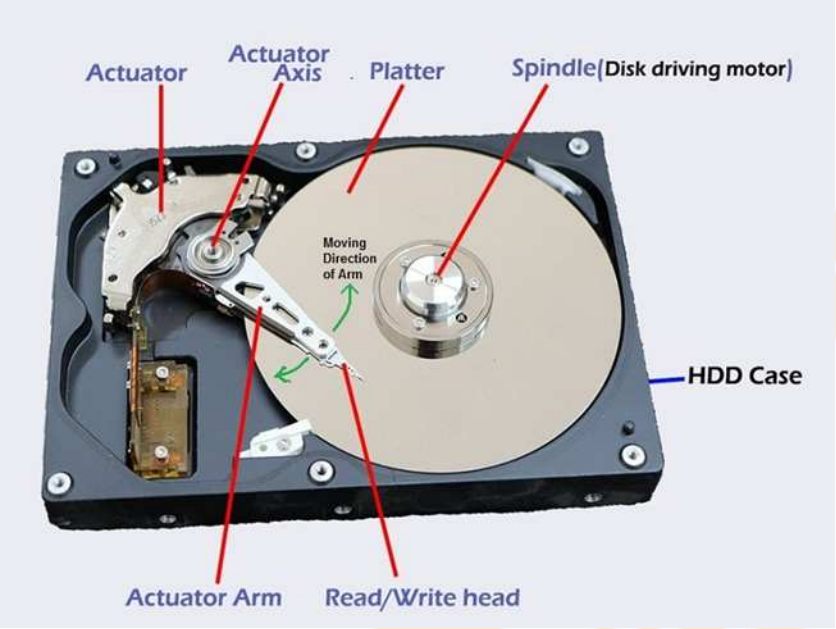
- Benefits:
  - The storage is permanent.
  - It can be modified any time.
  - The Price.
- Drawbacks:
  - The get high temperature and they are sensitive of vibrations.
  - The recorded data may be affected by high and low temperatures, humidity...
  - They can be affected magnetic fields
  - They have mechanical part

2.1 Elements of magnetic hard disk

Hard disks are composed by several elements:

- Platters: these elements are in charge of keeping the information even when the computer is off. It could be one or several platters stacked on top of each other.
- Actuator arms: at the end of these elements the heads are and for that reason, the arm is the element with more precision and the most important one. This element moves itself from right to left in order to access all the information .
- Heads: They are the elements in charge of reading, writing and deleting dates from the magnetic device. Heads don't touch the magnetizable surface and they read, write or erase through magnetic pulses. The platters have two sides in order to save information, so each platter will need 2 heads. The number of heads is limited by BIOS (16 max.).

- HDD case: The magnetic part of the Hard disk musn't have powder or any impurity. The HDD case gets that goal.



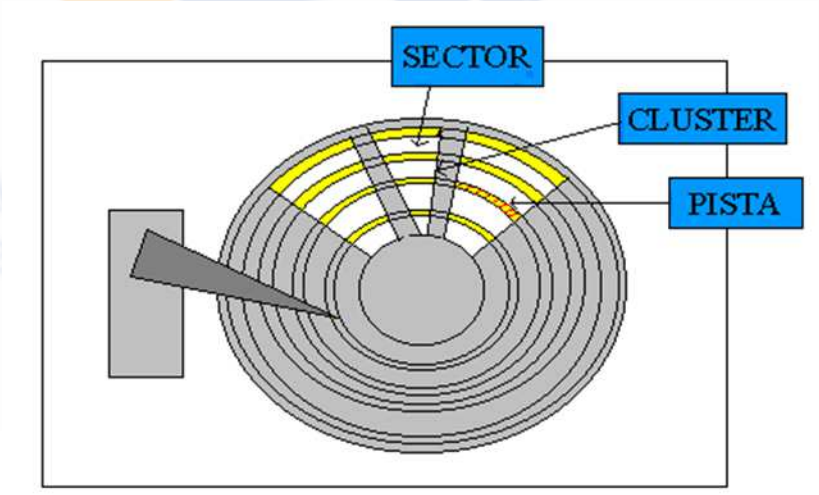
The platters are divided in areas:

Track: it is the circumference of the side. The 0 track is the most external track

Sector: tracks are divided in sectors. The size of each sector can vary but the most used sector size is 512 bytes. Because tracks are different depending on the situation (external track are bigger than internal), hard disks have more sectors in the external track than in the internal one. For this, advantage is taken of the platter surface.

Cluster: Set of sectors.

Cylinder: It is the same track but in different platters.



2.2 Addressing mode

There are two modes of addressing:

- Cylinder-Head-Sector (CHS): it was the first protocol of addressing and through the cylinder, head and sector it was possible to know the data position in the disk.

- Logical Block Address (LBA): that system consists in divide the disks in sectors and identify each sector with a number. This protocol is used nowadays.

2.3 Access time

The access time is the average spent by the hard disk to get ready to transfer data measured in nanoseconds. In others words, it is the time spent by the head in get the position in the sector and chosen track. It depends on the physical components and it is calculated with:

Acces time

$$Access\ time = seek\ time + latency$$

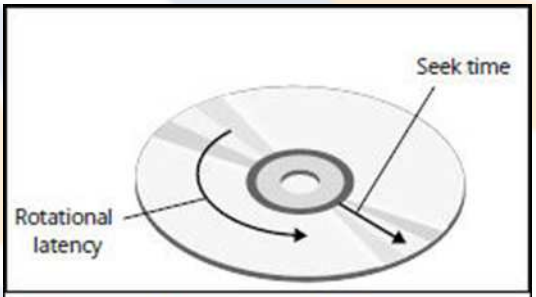
This time is calculated as average time because seek time and latency vary depending on the current position of the head and platter. To do this, it is necessary to get the average of seek time and the latency.

- Average seek time: it is the average of the time spent by the head in getting the position of the chosen track. It would be a half of the spent time to got the closer axis track to the furthest axis track.

$$Average\ seek\ time = Seek\ time/2$$

- Average latency: it is the average time spent by the head to be itself on the chosen sector.

$$Average\ latency = latency/2$$



Rotational Latency and Seek time

Try it

The speed of a hard disk is 5400 rpm:

1. What would be the average latency?

   A Hard disk does 5400 revolutions in 1 minute.

   $5400 \longrightarrow 60$
   $1 \longrightarrow x$
   $x = 11ms \longrightarrow$ Average latency: 5.5 ms

2. Keeping in mind that the seek time is 6 ms. What would be the access time?

   The average seek time will be $= 6/2 = 3$ ms $Access\ time = 5.5 + 3 = 8.5ms$

Try it

A hard disk has a transfer rate of 120 MB/s. How long does it take in transferring 2 GB?

2.4 Rotation speed

The rotation speed is the angular velocity of the hard disk platters. Normally, the rotation speed for hard disks of personal computers is 7200 rpm. In laptops it is 4500 or 5400 rpm and SCSI hard disk can be 15000 rpm.

2.5 Size of buffer or cache

The cache is used as a store. This part is necessary since the internal part of the hard disk (mechanical and magnetic part) is slower than the device driver. And at the same time, data are stored in the cache in case they are needed again. In that case, it isn't necessary to access to the hard disk to give faster respond.

The bigger capacity buffer, the better in order to give better performance. Normally, hard disks buffer are 8,16,32, 64 MB.

2.6 SMART Technology

S.M.A.R.T (Self Monitoring, Analysis and Reporting Technology) is a Technology thanks to which it is possible to foresee problems before it they occur. This Technology is included in almost all hard disks, however, it is necessary to enable it in BIOS and install some software in order to monitor warnings. This Technology measures a lot of variables as temperature, Flight altitude, position of head, temperatures... and it compares that values with nominal values. It warns the user with some uncommon value.

3 SSD hard disk

The flash memory is EEPROM. Data are not lost when the computer turn off but it is slower than RAM and it has a maximum of number of reading and writing.

3.1 Benefits and drawbacks of the SSD hard disk

The benefits of this are these:

- The most important is the speed in order to access to some data.
- Its power consumption is lower than the magnetic hard disks.
- It is quieter than the magnetic hard disk.
- Magnetism doesn't affect them
- Lower temperature.
- It can't be damaged by movements.

The drawbacks of that kind of hard disk are:

- It has a limited life
- It is not possible to recover data if some virus infects it
- More expensive.

3.2 Information Storage technologies

That kind of memory is formed by NAND chips in order to save data in permanent way. There are 4 kinds of Technology:

- SLC (SingleLevel Cell): they have a difficult process of fabrication. The point is that each cell of information has 1 bit. They are faster, with a longest life and lower consumption.
- MLC (Multi Level Cell): they have 2 bits of information in each cell and larger capacity is got with the same space. But they are slower and they have shorter life than the previous one. They are the most used.
- TLC (Triple Level Cell): they have 3 bits in each cell and they have larger but slower capacity than the MLC, with shorter life.
- QLC (Quad Level Cell): They have 4 bits in each cell but they have larger, cheaper but slower capacity, with shorter life than TLC Technology.

SSD hard disks have more capacity than it is indicated. That is because of the deterioration of the cells and the correction system of the hard disk drive are in charge of indicate that.

3.3 Form factor

- SATA: the format is 2.5" or 1.8" and it uses the SATA interface with the AHCI protocol of transfer.

- mSATA: that format is lower than the previous one but it is out of date since it has been replaced by M.2 form factor.

- M.2: this form factor was known as NGFF (Next Generation Form Factor). It is in charge of replacing mSATA form factor since that form factor is smaller and with a new connector. Several sizes are used: 2230, 2242, 2260, 2280, but the most common is the last one. They can transfer information through SATA or PCI-Express buses, but just in one of them and they are able to use the AHCI or NVMe protocol

There are expansion card which allow to connect the hard disk SSD M.2 to the PCI-Express bus.