Sistemas Informáticos (Computer Systems)

Unit 07. Hardware: External components - Part 2

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Licencia

Nomenclatura

A lo largo de este tema se utilizarán diferentes símbolos para distinguir elementos importantes dentro del contenido. Estos símbolos son:

📖 **Important**

❕ **Attention**

💬 **Interesting**

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Unit 07. Hardware: External components - Part 2

1. Introduction

In this topic, we will talk about the different peripherals used in most computers. Not absolutely all of them, as the existence of peripherals is limited by the imagination of designers and manufacturers, but the most important ones.

2. Power supply systems

In this section, we describe the main power supply systems for desktops and laptops.

2.1 Power supply

A power supply is a device that converts an AC voltage into one or more DC voltages.

Power supplies usually express the power rating (i.e. the power they can supply) in watts. This is not always equal to the power consumed. This is specified in the power supply's efficiency percentage, which indicates what percentage of the power consumed is actually consumed.

There are some websites such as https://es.msi.com/power-supply-calculator that allow you to estimate how much power a particular computer configuration will require, based on the maximum peak power consumption of each of the components.

Power supplies in computers are usually:

- Internal: in personal computers, generally following the ATX format.
    - Sometimes, they can follow this format and can be external, mount redundant power supply systems, etc.
- External: laptop transformer, Raspberry PI transformer, Video Console transformer, etc.

At this point, we will focus on ATX format power supplies.

These power supplies typically have dimensions of "150 × 86 × 140 mm". The dimensions may vary according to models, performance, size, etc.

They generally operate with an AC input voltage of 230V.

Power supplies usually have a series of protections that cut off the power supply. Some of the most common are:

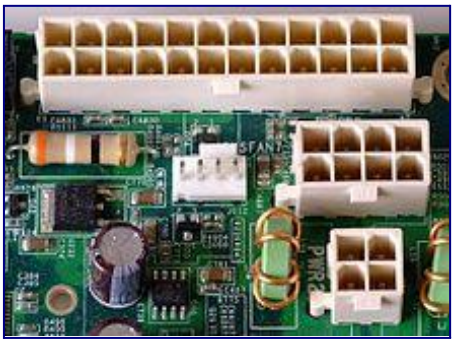
- Overvoltage protection.
- Overheating protection.
- Short circuit cooling protection (internal short circuit).

ATX power supplies usually have two types of connectors:

2.1.1 ATX connector

The 24-pin ATX connector is used to power the entire computer. It is the main connector. The 4-pin or 6 or 8-pin ATX 12V connector is used for extra power for the processor or graphics card. They are color-coded to indicate the type of power they provide.

Here is an example of connectors: ATX connector (20+4pin), 8pin and 4pin



In order to comply with the standard, power supplies also have to respect noise and oscillation limits on their voltage outputs, these limits are 120mV for 12+, 50mV for 5V+ and 3.3V+.

To start up an ATX power supply, the PS-ON (PowerSupplyOn) must be short-circuited to ground (COM). For repair/maintenance, this is usually done with a switch or simple electrically conductive tools such as a paper clip.

2.1.2 Molex connectors

The internal connectors of a desktop computer are often referred to as Molex. It is used on peripherals that require more amperage than the data cable provides, such as:

- Hard disks (IDE, SCSI, SATA)
- Floppy disk drives
- Optical drives (CD, DVD and Blu-Ray)
- Graphics cards
- Cooling systems (air and liquid)
- Modding elements (light-emitting diodes, light tubes, etc.)

2.2 Batteries

Batteries are commonly used in a multitude of portable devices: tablets, mobiles, laptops etc. Nowadays, batteries are usually Lithium-ion. More information on this technology can be found at https://es.wikipedia.org/wiki/Bater%C3%ADa_de_ion_de_litio

In terms of efficiency and performance, in addition to other parameters used in power supplies, the following units of measurement are commonly used in the case of batteries:

- **Milliampere hours (mAh)**: measure the charge of the battery. This is indicative to calculate the battery life, because if you have for example a 1000 mAh battery, you can give 100mA for 10 hours or 1000mA in a single hour.
- **Cells**: The cells that make up a battery are actually mini-batteries put in series. Each battery is made up of a set of cells. All things being equal, the greater the number of cells, the greater the durability, but the greater the space and weight.

The advantages of these batteries include:

- Value for money/performance ratio.
- Little memory effect.
- High energy in relation to weight.
- Low self-discharge rate.
- Easy detection of the load percentage.

Among the drawbacks:

- They are very much affected by the heat.
- Rapid degradation (lifetime measured in charge cycles).

Although in theory batteries only have a positive and negative pole, in practice most batteries have more terminals.

In the end, each battery is a "mini-computer" with different features, and these usually depend on the manufacturer. One example is that this type of battery usually has protection against over-charging, indicating that when it detects that the battery has been fully charged, the circuit is cut off.

2.3 Uninterruptible Power Supply Systems (UPS)

An Uninterruptible Power Supply (UPS) is a device that will supply electricity to a computer in the event of a power failure, allowing it to work for several minutes. The performance of a UPS is measured in volt-amperes (VA) and is basically the apparent power that the UPS can provide. More information at https://es.wikipedia.org/w/index.php?title=Potencia_el%C3%A9ctrica&section=4#Potencia_aparente

Generally, a UPS consists of these components:

- **Battery:** stores direct current (DC) and has a certain charge capacity, measured in ampere-hours (Ah)**.**
- **Charger**: has a rectifier that converts alternating voltage (AC) to direct voltage (DC) to charge the batteries.
- **Inverter**: converts the direct current (DC) from the battery into alternating voltage (AC). This AC voltage will be supplied to the load.
- **Selector: allows the** load to be supplied by the inverter or directly by the grid.

There are also different types of UPS depending on how they work or function:

- **Standby UPS**: the inverter is "off-line" or idle, waiting to come “on-line” in the event of a mains power failure.
- **On-Line UPS**: performs the same functions as the Standby UPS but includes elements to correct voltage and frequency shifts, etc., i.e. it regenerates the alternating wave using the battery.
- **Double Conversion UPS:** is used for equipment that is very sensitive to power fluctuations and needs to have a strong electrical isolation. In these UPS the batteries are always connected to the inverter. When power loss occurs, the rectifier simply drops out of the circuit and the batteries keep the power constant and unchanged.

3. MAIN PERIPHERALS

In this section, we will describe the fundamentals and characteristics of the main peripherals used in personal computers.

3.1 Keyboard

The keyboard is an input device consisting of an arrangement of keys, to act as mechanical levers/electronic switches that send information to the computer.

In the past, keyboards used to use the PS2 port, but nowadays, the USB port for wired keyboards and Bluetooth for wireless keyboards are the most commonly used.

The most commonly used technologies in the construction of keyboards are:

- Membrane keyboards: most of today's keyboards. The keys press on a membrane that makes contact with an electronic circuit.
- Capacitive keyboards: detect the approach of the finger to the keyboard.
- Mechanical keyboards: mechanical components, more resistant and the keystroke is progressive.

There are several keyboard layouts, the most widely used being QWERTY. Other famous layouts include DVORAK, designed to minimize typing errors, although it is not widely used https://es.wikipedia.org/wiki/Teclado_Dvorak.

Within the same keyboard layout, there may be variations between countries, such as the Ñ on the Spanish keyboard.

3.2 Mouse

The mouse is a peripheral device that detects relative movement in two dimensions on the flat surface on which it rests, usually reflected by a pointer or arrow on the monitor. There are variants that are based on the displacement of the finger on a surface, called Touchpad.

The movement is usually reflected on the screen by an arrow.

Wired mice are usually connected either via the PS2 port or via USB. Today's wireless mice usually use radio frequency or Bluetooth.

We generally distinguish between two types according to their technology:

- **Mechanical**: They have a sphere at the bottom to move two wheels that generate pulses in response to the movement of the sphere on the surface.
- **Optical**: these are currently the most commonly used. Their operation is based on an optical sensor that photographs the surface on which it is located and by detecting the variations between successive photographs, it is determined whether the mouse has changed its position. There are two main types: Laser (uses an infrared laser to illuminate

the surface) and LED (uses LED diodes).

- The main things to measure in mice are their response time and their accuracy in dpi (dots per inch).
- Some mice have configurable sensitivity levels.

3.3 Sound cards and speakers

A sound card is a card (often integrated in the board itself) that manages audio inputs and outputs. The most widely used standard is Intel High Definition Audio, defined in 2004 https://en.wikipedia.org/wiki/Intel_High_Definition_Audio.

Some general characteristics of sound cards are the types of audio outputs (2.0, 2.1, 5.1, 7.1).

Sound cards, in order to use certain features, must be matched with speakers of similar characteristics. The general characteristics of the speakers are:

- Connection: wired or Bluetooth.
- Number of channels.
- Elements related to power and sound quality.

3.4 Webcam

A webcam is a small digital camera that can capture images and transmit them over the Internet. Some also have a built-in microphone to capture audio. They are usually connected via USB.

There is a variant called IP webcams that have the entire infrastructure to broadcast over the Internet without the need for an associated computer. Many of these webcams are also equipped with motors to move them and are often used for surveillance purposes.

The main differentiating feature is its optical sensor. Nowadays, there are even webcams that can record and transmit in FULL HD. Generally speaking, its features are:

- The engraving resolution (pixels)
- The number of bits per color.
- The number of frames per second.
- Hardware compression algorithm(s).

4. Printing elements

In this section, we will describe the main types of printers and their consumables.

4.1 General characteristics of the printers

Some general characteristics of the printers are described below:

- **Type of connection**: Many printers are used as peripherals, and are permanently connected to the computer by a cable via a USB connector. Other printers, called network printers, have a network interface (Wireless or Ethernet) and function autonomously as a print server.
- **Print time**: The time taken to print a page. Printers are generally slow devices (10 pages per minute is considered fast) and the cost per page is relatively high.
- **Type of printing**: generally in color or black and white.
- **Resolution**: The resolution achieved in printing. Specifically, it is the number of individual dots of ink that a printer or toner can produce in a linear space of one inch. It is usually measured in dpi (pixels per inch) or dpi.

- **First page out time**: this is the time taken by the printer to print the first page. Depending on the technology, it can range from negligible (inkjet) to a high value (laser/LED).
- **Duplex option**: A feature of printers that allows a sheet of paper to be automatically printed on both sides of the paper. Most printers can automatically print on one side of the paper only. Duplex printers use a special document feeder that flips the paper over after the first side has been printed. **NOTE**: Manual duplex means that you do not have the duplex option, but that you print the odd sides first and then put this newly printed paper back in the drawer and print the even sides.

4.2 Inkjet printers

Inkjet printers consist of nozzles that produce very small bubbles of ink that are converted into very small ink droplets (picoliters). The dots formed are the size of tiny pixels. Inkjet printers can print high quality text and graphics almost silently.

There are two methods for injecting the ink:

- **Thermal method**. An electrical impulse produces a temperature rise (approx. 480 °C for microseconds) which causes a small quantity of ink to boil inside a chamber, forming a vapor bubble which forces it out through the nozzles. This vapor condenses and forms an ink droplet on the paper. The resulting vacuum then draws the new ink into the chamber. This method has the disadvantage of greatly limiting the life of the nozzles, which is why these nozzles are found in the ink cartridges.
- **Piezoelectric method**. Each injector consists of a piezoelectric element which, when it receives an electrical impulse, changes shape by abruptly increasing the pressure inside the head, causing an ink particle to be injected. Its injection cycle is faster than the thermal cycle.

To reduce costs and maintenance of inkjet printers, a continuous ink system is sometimes used. This is a system to avoid frequent replacement of ink cartridges in an inkjet printer.

Compared to an ink cartridge system, the continuous ink system uses large tanks (containing between 50ml and 100ml of each color) which are connected to the printheads via tubes. The containers can be filled with small bottles of ink, without the need for syringes.

This reduces ink costs (compared to continuous replacement of cartridges) and reduces maintenance (only if the cartridge is damaged does it need to be replaced).

4.3 Laser or LED printers

In laser or LED printers, the central device used in this type of printing is a photosensitive material that is electrically discharged by light, called a photo-receptive drum. To print, this drum is positively charged by an electric current running along a filament. The cylinder then rotates at a speed equal to that of a small laser beam, the direction of which is controlled by a motor with mirrors located polygonally on the inside of the laser unit.

This beam discharges (negatively charges) tiny parts of the cylinder, thus forming the electrostatic (non-visible) image of our document to be printed on this photo-receiver.

Subsequently, the drum is bathed in a very fine black powder, called toner, which is positively charged and therefore adheres to the negatively charged parts. The positively charged parts repel this powder, which forms the visible image on the drum. This image formed on the drum is transferred to the paper by means of a negative charge greater than that on the cylinder.

The toner that was transferred to the paper is then adhered to the paper by a device called a fuser. This device consists of a pair of rollers: one of them is responsible for generating heat and the other one has the purpose of pressing the sheet on top of the previous one. The heating time of the fuser can affect how long it takes to print the first page.

The remaining toner in the cylinder is cleaned by means of a plastic foil, and at the same time light is shone on the cylinder to make it completely discharged.

4.4 3D printers

Although they do not fall into the classic printing category, we include them here to comment on some of their characteristics. A 3D printer is a machine capable of creating parts from a computer design. They arise with the idea of converting 2D files into real or 3D prototypes.

It has commonly been used in the manufacture of parts or components.

There are currently two types of business models:

- Compaction, with a mass of dust that is compacted in strata.
- Addition, or polymer injection, where the material itself is added in layers.
- Depending on the method used for powder compaction, 3D printers can be classified as follows:
- Ink 3D printers: use a binder ink to compact the powder. The use of one ink allows printing in different colors.
- Laser 3D printers: a laser transfers energy to the powder, causing it to polymerise. It is then immersed in a liquid that causes the polymerised areas to solidify.

Once all the layers have been printed, all you have to do is remove the part. With the help of a hoover, the excess powder is removed, which can be reused in future prints.

4.5 Other types of printers

4.5.1 Impact printers

Impact printers rely on the force of impact to transfer ink to the medium, similar to typewriters. These types of printers are typically limited to reproducing text or pre-set characters.

4.5.2 Matrix printers

A dot matrix printer is a type of printer with a print head that moves from left to right on the page, printing by impact, pressing an ink ribbon against the paper, similar to the way a typewriter works. Unlike typewriters or printing printers: the letters are obtained by selection of dots from a matrix, and therefore it is possible to produce different typefaces, and graphics in general.

4.5.3 Thermal printers

Not to be confused with thermal inkjet printers.

A thermal printer is based on a series of heated needles that run through a special thermo-sensitive paper that turns black when in contact with heat. Due to their low cost (only the paper is consumed) they are widely used in ATMs, shops, etc.

The durability of the print is relatively low as the wear and tear on the paper, particularly at high temperatures, causes the text written on the paper to be lost.

4.5.4 Sublimation printers

A dye-sublimation printer is a printer that uses heat to transfer ink to the media from a ribbon with 5-color CMYK ("Cyan, Magenta, Yellow, Black") ink.

They are intended for high quality color applications, such as professional photography, and are not recommended for text.

4.6 Consumables and costs

4.6.1 Measurement of number of printed pages

Laser and inkjet printers indicate the capacity of their consumables by measuring pages. In real life, the cost in vat/toner for each page is variable and depends on the characteristics of your print.

The measure used commercially comes out of the cost of filling 5% of a DIN-A4 page.

For example, for the case of an 8000-page toner if we take a DIN-A4 page and divide it into 100 equal squares, if we only print 5 of these squares completely black on each page, we could print 8,000 similar pages with the same toner. By this measurement, printing the entire page in black would be like printing 20 pages.

4.6.2 Printing costs for inkjet printers

Inkjet printers have a much lower initial cost than Laser/LED printers (their technology is cheaper), but have a much higher cost per copy, as the ink needs to be replenished frequently.

Inkjet printers are also slower than laser/LED printers and have the disadvantage of having to let the pages dry before they can be handled. In addition, they cope poorly with long print times (e.g. printing more than 30 sheets at a time) and the nozzle heads tend to get dirty.

Another problem is that the ink tends to dry out, so if the printer is not used regularly, the nozzles become clogged with dried ink. Their consumables are called **cartridges**. Their capacity is measured in milliliters (ml). Each 10 ml prints approximately 200 pages. Cartridge refills are expensive. In addition, with frequent printing, production has to be stopped every time the cartridge or printer is changed.

4.6.3 Printing costs for Laser/LED printers

Laser/LED printers have a much higher initial cost than inkjet printers because they have more electronic components and these are much more complex.

Laser printers are cost-effective when printing frequently, as the cost per page is very low.

However, laser/LED printers have a higher power consumption than inkjet printers because laser printers must maintain a certain degree of heat in the fuser. Consumables are:

- **Toners:** changed approximately every 6,000 sheets.
- **Drums:** are replaced approximately every 20,000 pages.
- **Fuser blades:** replace approximately every 60,000 pages.
- **All-in-one**: there are printers where the toner, drum and fuser are all in one piece, so they can be changed all at once: they are more expensive to maintain but easier to change.

5. STORAGE ELEMENTS

5.1 Magnetic storage

Magnetic storage is a technique that consists of applying magnetic fields to certain materials capable of reacting to this influence and orienting themselves in certain positions and holding them until after the magnetic field is no longer applied.

5.2 Optical storage

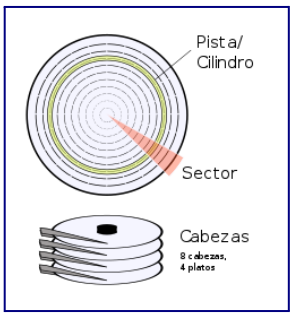
Optical storage is a technique that consists of writing and reading data by means of a laser beam on its plastic surface, where the data is stored by means of microscopic burnt grooves. The information is physically recorded on the surface, so only heat (can cause deformation of the disk surface) and scratches can cause data loss, but it is immune to magnetic fields and humidity.

5.2.1 File system

Optical media follow the UDF (Universal Disk Format) and Joliet file system. This file system was adopted to replace the ISO 9660 standard, and its main use is for recording or re-recording discs.

5.2.2 Read/write system

The reading of an optical medium consists of the conversion of the *lands* and *pits* into digital information (zeros and ones). The key element for reading optical media is a low-power laser, which emits radiation and is focused on the underside of the CD. The light passes through the polycarbonate layer and strikes the aluminum layer. If the beam hits a pit, the percentage of reflected light is very small. On the other hand, if the beam is incident on a flat area (land), a large percentage of light is reflected. The reflected light radiation is directed towards a photo-detector which, depending on the intensity of the light received, can easily detect whether a land or a pit is in focus.



There is no direct association between lands and pits and '0' and '1'. Simply, when there is a land the value is maintained and when there is a pit the value is inverted (from 0 to 1 or from 1 to 0).

An optical carrier does not contain concentric tracks. Instead, the optical carrier has a single track, which is arranged in a spiral pattern, covering the entire data area.

5.3 Magnetic Hard Disk

A magnetic hard disk is a non-volatile data storage device that employs a magnetic recording system to store digital data.

Inside a magnetic hard disk there are one or more concentric (aluminum or glass) disks called platters (usually between 2 and 4), which all rotate at the same time on the same axis, to which they are attached.

The reader consists of a set of arms parallel to the platters, vertically aligned (comb-shaped) and also moving simultaneously, at the tip of which are the read/write heads.

As a general rule, there is one read/write head for each platter surface. The heads move towards the inside or outside the platens, which combined with the rotation of the platens allows the heads to reach any position on the platter surface.

The read/write heads never touch the disc, but pass very close due to a very thin film of air generated by the platter as it rotates. If any of the heads were to touch a platter surface, it would cause a lot of damage to the platter, severely scratching it, because of how fast the platters spin.

5.3.1 Addressing

There are several concepts to refer to areas of the disc:

- **Platter**: each of the disks inside the hard disk.
- **Side**: each of the two sides of a plate.
- **Head**: number of heads.
- **Tracks**: a circumference inside a face; track 0 is on the outer edge.

- **Cylinder**: set of several tracks; they are all the circumferences that are vertically aligned (one on each side).
- **Sector**: each of the divisions of a track. They all have the same size. The current standard size is 4096 bytes.
- **Cluster**: A contiguous set of sectors on a disk.

In the past, addressing to indicate a position was done by indicating the values C, H, S (Cylinder, Head, Sector). To overcome certain limitations, LBA (Logical Block Addressing) was born, which consists of dividing the entire disk into sectors and assigning a unique number to each one. This addressing is the one currently in use.

5.3.2 General characteristics of magnetic hard disks

The characteristics to be taken into account in a magnetic hard disk are:

- **Average seek time**: the average time it takes for the head to position itself on the desired track. It is half the time taken by the head to go from the most peripheral track to the most central track on the disc.
- **Rotation speed**: revolutions per minute of the platters. The higher the rotation speed, the lower the average latency.
- **Average latency**: the average time it takes for the head to position itself in the desired sector. It is half the time taken for a complete rotation of the disk.
- **Average access time**: this is the sum of the average search time (getting on the runway) + the average latency (getting on the sector).
- **Transfer rate**: speed at which the disc can transfer information to/from the computer once the head is positioned on the correct track and sector.
- **Read transfer rate:** this is the speed at which a file is transferred from the magnetic disk.
- **Write transfer rate:** this is the speed at which a file is transferred from any program to the magnetic disk. In this case, it is usually lower because after the data is written, it is usually checked to see if it is well written.
- **Read/write time**: Average time it takes for the disk to read or write new information. It depends on the amount of information to be read or written.
- **Cache**: is an electronic type of memory inside the hard disk that stores recently read and/or written data, reduces disk usage and repetitive reads or writes of data, and improves the speed of data access.
- **Buffer**: memory that allows the operating system to improve the writing of the disk (the operating system writes to the buffer and is written to the disk later).
- **Interface**: Means of communication between the hard disk and the computer. Depending on the interface and its version, the maximum transfer rate of the interface can vary greatly. It can be IDE/ATA, SCSI, SATA, USB, etc...
- **Form factor**: usually 3.5 inches for desktops/servers and 2.5 inches for laptops, portable disks, etc.

5.4 DVD

The DVD is a data storage disc. It stands for Digital Versatile Disc. It has been commonly used to store video. For data storage it is often referred to as DVD-ROM (read-only device), DVD-R and DVD+R (can only be written once), DVD-RW and DVD+RW (can be recorded and then erased).

The DVD-ROM stores from 4.7 GB to 17 GB. Depending on the number of layers or sides:

- DVD-5: single-sided, single layer; 4.7 GB or 4.38 GiB. DVD±R/RW discs.
- DVD-9: single-sided, dual layer; 8.5 GB or 7.92 GiB. DVD+R DL discs. Dual layer recording allows DVD-R and DVD+RW discs to store significantly more data, up to 8.5 GB per disc, compared to 4.7 GB for single layer discs.
- DVD-10: two-sided, single layer on both sides; 9.4 GB or 8.75 GiB. DVD±R/RW discs.

- DVD-18: two-sided, dual layer on both sides; 17.1 GB or 15.9 GiB. DVD+R discs.

5.5 Blu-ray

Blu-ray is a new generation optical disc format, used for high definition video and with a higher density data storage capacity than DVD.

The Blu-ray disc is 12 cm in diameter, like the CD and DVD. It stored 25 GB per layer, but Sony and Panasonic developed a new evaluation index (i-MLSE) that would allow a 33% increase in the amount of data stored, from 25 GB to 33.4 GB per layer.

The Blu-ray disc makes use of a blue laser beam with a wavelength of 405 nanometers, as opposed to the red laser used in DVD players, which has a wavelength of 650 nanometers.

This, together with other technological advances, makes it possible to store substantially more information than DVD on a disc of the same dimensions and external appearance. Blu-ray gets its name from the blue color of the laser beam (blue ray means 'blue ray').

5.6 USB memory stick

A USB flash drive (Universal Serial Bus) is a storage device that uses flash memory to store information.

These memories have become the most widely used personal data storage and transport system, displacing traditional floppy diskettes and CDs. Memory sticks ranging from 1 GB to 1 TB are readily available on the market.

Today's operating systems can read and write to the memory sticks by simply plugging them into a USB connector on the powered-on computer, receiving their power supply through the 5-volt connector itself.

Despite their low cost and low warranty, it is important to bear in mind that these storage devices can suddenly stop working due to various accidents: voltage variations while connected, drops, prolonged use over several years, especially in the case of older pen drives.

Flash drives are immune to scratches and dust that affect previous forms of portable storage such as compact discs and floppy disks.

Flash memory can withstand a finite number of read/write cycles before failing. In normal use, the average range is around several million cycles. However, write operations will become increasingly slower as the drive ages.

5.7 SSD (Solid-State Drive)

An SSD is a data storage device that uses non-volatile memory, such as flash memory to store data, instead of the magnetic spinning platters found in conventional hard drives.

Compared to traditional hard drives, solid state drives are less sensitive to shock, are virtually inaudible and have lower and constant access time and latency. SSDs make use of the same interface as hard drives and are therefore easily interchangeable without having to resort to adapters or expansion cards to make them compatible with your computer.

Almost all manufacturers market their SSDs with non-volatile NAND flash memory to develop a device that is not only fast and with a vast capacity, but also robust and yet as small as possible for both the consumer and professional markets.

As non-volatile memories, they do not require any constant power supply or batteries in order not to lose the stored data, even in sudden power outages.

They are marketed in the dimensions inherited from hard disk drives, i.e. in 3.5-inch, 2.5-inch and 1.8-inch, although some SSDs also come in "expansion card" format.

In some cases, SSDs can be slower than hard drives, especially with older, low-end controllers, but since SSD access times are negligible, they are ultimately faster. This shorter access time is due to the absence of mechanical moving parts, which is inherent to hard drives.

An SSD is mainly composed of:

- **Controller**: This is an electronic processor that manages, manages and links the NAND memory modules with the input and output connectors. It runs firmware-level software and is certainly the most important determinant of device speeds.
- **Buffer**: An SSD device uses a small DRAM memory device similar to the cache on hard disks. The directory block placement and data leveling wear is also maintained in the cache while the drive is operational.
- **Capacitor**: Required to maintain the integrity of the data in the cache memory, if the power supply has unexpectedly stopped, long enough for the retained data to be sent to the non-volatile memory.

6. Visualization and digitization elements

In this section, we will describe the different elements of visualization and digitization.

6.1 Monitor

The monitor is an output device (interface), which displays data or information to the user.

6.1.1 Technologies

Older monitors used CRT (Cathode Ray Tube) technology. This is a technology that allows images to be displayed by means of a constant cathode ray beam directed against a glass screen coated with phosphor and lead. Currently, there are several technologies, combining the TFT transistor type https://es.wikipedia.org/wiki/Thin-film_transistor (which is not a technology in itself) with several technologies (LCD, LED, OLED), each with its pros and cons.

6.1.2 General characteristics of the monitors

In general, the monitors have the following features:

- **Pixel**: The smallest representable unit on a monitor. Monitors may have dead or stuck pixels. They are noticeable because they appear white.
- **Resolution:** These are two measurements in the number of pixels that our screen can support, horizontally and vertically. It determines the sharpness of an image.
- Dot pitch: Dot pitch is the space between two colored phosphors of a pixel. It is a parameter that measures image sharpness by measuring the distance between two dots of the same color; it is critical at higher resolutions. Smaller dot sizes produce more uniform images. It is sometimes different vertically than horizontally, or it is an average value, depending on the particular arrangement of the colored dots on the screen, as well as the type of grating used to direct the electron beams.
- **Viewing angle**: This is the maximum angle at which the monitor can be viewed without excessive image degradation. It is measured in degrees.
- **Luminance**: is the measure of brightness, measured in candelas. The higher the luminance, the better it will be seen in brightly lit areas.
- **Response time**: also known as latency. It is the time it takes for a pixel to go from active (white) to inactive (black) and then back to active again.
- **Contrast**: The ratio of brightness of a black pixel to a white pixel that the monitor is able to reproduce. It is something like how many shades of brightness the monitor has.

- **Image Contrast Ratio**: refers to how vivid the colors are for the brightness ratio used. The higher the ratio, the more vivid the colors (30,000:1 would show less vivid colors than 50,000:1).
- **Power consumption**: the amount of energy consumed by the monitor, measured in watts.

6.1.3 Screen size and aspect ratio

The screen size is the diagonal distance from one corner of the screen to the opposite corner. The aspect ratio is a measure of the proportion between the width and height of the screen, so for example a ratio of 4:3 means that for every 4 pixels of width we have 3 pixels of height.

These two measures describe the size of what is displayed on the screen. Historically, until not so long ago, computer monitors, like televisions, had a 4:3 aspect ratio. Later standards were developed for 16:9 widescreen aspect ratio displays.

6.2 Touchscreen monitor

A touch screen is a transparent screen overlapping a computer monitor that by a direct touch on its surface allows the input of data and commands to the device, and in turn displays the results entered. There are currently touchscreens that can be installed on a normal screen of any type (LCD, CRT monitors and televisions, plasma, etc.).

Depending on the technology they use, they can be:

- **Resistive**: they work by detecting pressure at a point. They are cheaper and unaffected by dust and water and, in addition to being more accurate, they can be used with a stylus or a finger or a generic glove. However, they have up to 25% less brightness and are thicker.
- **Capacitive**: Based on capacitive sensors, they consist of an electrically insulating layer, such as glass, coated with a transparent conductor. As the human body is also an electrical conductor, touching the screen surface results in a distortion of the electrostatic field of the screen, which is measured by the change in capacitance (electrical capacitance). Different technologies can be used to determine at which position on the screen the touch was made. The position is sent to the controller for processing. The image quality is better, they have better response, and some allow the use of several fingers at the same time (multitouch). However, they are more expensive and cannot be used with a normal stylus.

6.3 Video projector

A video projector or video projector is a device that receives a video signal and projects the corresponding image onto a projection screen using a lens system, thus allowing still or moving images to be displayed.

The most common are LCD/LED projectors. To make the images visible, LCD/LED projectors send the light from a lamp, which can be either metal halide or LED, through a prism or a series of dichroic filters that separate the light by directing it to three separate panels for each of the components of the additive mix of the video signal: red, green and blue.

6.4 Scanner

A scanner is a peripheral used to convert, through the use of light, printed images or documents into digital format. Scanners may have accessories such as an automatic sheet feeder or an adaptor for slides and transparencies.

When a digital image is obtained, defects can be corrected, a specific area of the image can be cropped or text can be digitized using OCR techniques. These functions can be performed by the device itself or by special applications.Nowadays, it is common to include a printer and a scanner in the same device. These are called multifunction printers.

The general characteristics of the scanners are:

- **Color depth**: depends on the characteristics of the scan vector (the first of the basic characteristics defining the quality of the scanner) which is normally at least 24 bits.
- **Resolution:** usually measured in dots per inch dpi or dpi. Instead of referring to the actual optical resolution of the scanner, scanner manufacturers prefer to refer to the interpolated resolution, which is much higher due to software interpolation.
- **Pages per minute:** Number of pages you can scan per minute.

6.5 Barcode scanner

A barcode scanner is a scanner that, by means of a laser or LED, reads a barcode and outputs the number shown on the barcode, not the image.

Barcodes are read by passing a small spot of light over the printed barcode symbol. You only see a thin red line emitted from the laser scanner, but what happens is that the dark bars absorb the light source from the scanner and the light is reflected back into the luminous spaces. A device in the scanner takes the reflected light and converts it into an electrical signal.

The scanner's laser (light source) starts reading the barcode in a white space (the fixed area) before the first bar and continues to pass over the last line, ending in the white space after it. Because the code cannot be read if the scanner is passed outside the symbol area: the heights of the bars are chosen in such a way that the reading area is kept within the barcode area. The longer the information to be encoded, the longer the barcode required. As the length increases, so does the height of the bars and the spaces to be read.

6.6 Digitizing tablet

A digitizing tablet is a peripheral that allows the user to enter graphics or drawings by hand, just as they would with pen and paper. It also allows pointing and pointing to objects on the screen. It consists of a flat surface on which the user can draw an image using the stylus (pen) that comes with the tablet. In most models the image does not appear on the tablet but is displayed on the computer screen.

There are two main types:

- **Passive tablets**: Passive tablets make use of electromagnetic induction, where the horizontal and vertical wire mesh of the tablet operates both transmitting and receiving the signal. The digitizing tablet generates an electromagnetic signal, which is received by the resonant circuit in the pen.

  When the tablet switches to receive mode, it reads the signal generated by the pen. This information, in addition to the coordinates where it is located, may include information about pressure, buttons on the pen or the angle on some tablets.
- **Active tablets**: They differ from the previous ones in that the pen contains a battery inside it that generates and transmits the signal to the tablet. The pens are therefore larger and heavier than the previous ones.

7. Graphic cards

7.1 Graphic cards basis

In most computers, we represent images. The component which is responsible for interpreting the graphic data that come to the microprocessor and transform them into a signal that can understand the monitor is what is usually called graphic card or graphic adapter.

Today we can find graphic cards on those places:

- **Integrated into the chipset:** frequent office PCs, small and portable PC. In general, any

system that does not require a lot of graphical power.

- Integrated into the CPU: some processors have included the adapter. This provides advantages such as lower consumption, lower latency and lower price, but without a great 3D performance.
- I**ntegrated motherboard.** Not to be confused with the integrated into the chipset. This is a separate chip. They have the disadvantage that power is often limited. Usually a widely it used on computers that require little graphics requirements, such as servers.
- **Expansion cards**: the usual graphics cards. The reason for its use is to connect more monitors or to increase performance.

Current graphics cards have a higher complexity of the rest of the PC. For example, a Core i5 with 4 cores has 750 million transistors, but a graphics chip can have between 1500 and 2000 million transistors and all of them in a dedicated way. The problem is that life is very limited.

7.2 Screen resolution

The screen resolution is the number of points that form the image that will be displayed in the monitor expressed as "horizontal dots x vertical dots" for example 1280x1024. The greater the resolution will be, the detail that will be on display. However, the chosen resolution should be consistent with the size and type of monitor:

LCD monitors have a fixed dot matrix called native resolution, these monitors can represent other than native resolutions but with much poorer quality.

Any graphics card can handle very high resolutions in 2D and 3D static (photos), but in dynamic 3D (games) any increased resolution is a sudden drop in performance to unbearable limits.

In general, the higher the resolution the image quality will be higher, offer a greater field of work and also, if the monitor is large, the view is less tiring.

Each resolution has a certain aspect ratio (aspect ratio) is the ratio of the horizontal size and vertical size of the image, which should be identical to the display device. The most common aspect ratio is 4: 3 (1024x768) and 5: 4 (1280x1024), commonly called square or 16: 9 (1366x768) and 16:10 (1680x1050), called panoramic.

7.3 Number of colors

Also called color quality or color depth. It is the number of different colors that can reach each of the screen pixels. It is usually expressed by the number of bits. Nowadays, the minimum is 65,536 colors (16 bits), although it is usual 16.7 million colors (24 bits), also called true color or even 32 bits.

7.4 GPU

GPU (Graphics Processing Unit) is a processor such as CPU, but specifically dedicated to graphics processing; its task is to reduce the workload of the central processor, being optimized for floating point computing, which is the type of data that is handled more 3D operations.

GPUs are able to perform certain operations denominated graphics primitives, as the drawing of certain basic shapes: rectangles, triangles... as well as the pre-processing and post-processing for high quality images like anti-aliasing, accelerating the screen representation of the images much more than if these were made via software.

Today, the manufacturing market's GPU graphics cards for PC are focused on two companies: nVidia and ATI. That is why the first decision when choosing a graphics card is to chose one of them.

7.5 Video Memory

Video memory is memory dedicated solely to the use of the graphics card, the place where information of the calculations performed by the graphics chip is stored. Formerly, the only function was to serve video memory frame buffer (storage space for the image before moving on to the monitor).

Today, in graphics cards with 3D functions, things change. Memory is used to store data from multiple additional functions, such as the depth of the image points (ZBuffer), textures, images to apply anti-aliasing, etc.

Nowadays, the most normal is found between 1 GB and 4 GB of GDDR5 memory.

If the dedicated memory on the graphics card it is over, RAM memory is used as video memory, making the 3D performance much lower.

7.6 Drivers

To handle the graphics card and take full advantage, an OS-dependent software called device driver is required. Drivers can affect much the performance or operation in general. When you buy a graphics card, it is important to check the support that the manufacturer gives the OS we intend to use. It is the manufacturer who must provide the drivers for the graphics card, although almost always (but not always) generic drivers can be used by the chip manufacturer.

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