Introduction to computers

a. **System case:** It is a metallic box where power supply, mother board, power button and switches, different parts and many other components are kept.
b. **Styles and sizes:** Computer case comes with different shapes and sizes which differ from manufacturer to manufacturer but are similar in the way they give space to different components. Form factor Form factor of system case, power supply, and motherboard means their shape, size, the number and types of different components they support.
c. **Form factor:**
   i. ***LPX style-*** It is loosely defined format of power supply which differs mainly in shape. It restricts the flow of air within the system mainly. It stands for low profile extension.
   ii. ***ATX style:*** It is defined as a format which emphasis on system cooling more efficiently. It stands for Advanced Technology Extension
   iii. ***NLX Style***: It supports expansion BIOS slots and AGP. It has brought the concept of replacement of motherboard without screws. It stands for New Load Profile Extended

1.1) **Power:** Computer is an electronic device so it works with the help of electricity. Different components of computer need power in different voltages in dc form. Power supply unit (PSU or SMPS) converts AC to DC and different voltages like +12V,-12V,+3.3V,+5V,-5V and ground which are applied to motherboard, Hard disk, CD drive etc. as necessary.

1.1.1) **Motherboard and system Devices:** A motherboard is one of the most essential parts of a computer system. It holds together many of the crucial components of a computer, including the central processing unit (CPU), memory and connectors for input and output devices. If the processor is the "brain" of the computer, then the motherboard is the central nervous system and circulatory system. Here are the main parts of the motherboard and its related devices:

- Motherboard: The motherboard is the main circuit board in the computer where everything comes together. This is where you plug in your processor, memory, cache, video card and other cards. It is also where you connect your peripherals.
- System Chipset and Controllers: The chipset and other motherboard circuitry are the "smarts" of the motherboard. Their job is to direct traffic and control the flow of information inside the computer. These circuits control the processor's access to memory, the flow of data to and from peripheral devices and communications lines, and much more.
- System Buses: The system buses are the electrical channels through which various parts of the computer communicate. The physical part of these buses, the part you see, is the set of slots in the back of the machine into which you put your video card, sound card and other cards. It is over the system buses that your video card gets information from the processor; the processor saves data to your hard disk, etc.

- BIOS: The system BIOS(which stands for Basic Input/output System) is a computer program that is built into the PC's hardware. It is the lowest-level program that runs on your computer. Its job is to act as an intermediary between your system hardware (the chipset, motherboard, processor and peripherals) and your system software (the operating system). By doing this, the operating system doesn't have to be made different for every machine, which is why DOS will load on any PC.
- Cache: The system cache is a small, high-speed memory area that is placed between the processor and the system memory. The value of the cache is that it is much faster than normal system memory. Each time the processor requests a piece of data from the memory, the system first checks the cache to see if the information is there. If it is, then the value is read from cache instead of memory, and the processor can get back to work that much sooner.

1.1.1.1) **Motherboard Form Factors:** The motherboard form factor describes its general shape, the type of case and power supply it can use, and its physical organization(layout of the motherboard)

- AdvancedTechnologyExtended(ATX):Thishasbeenthestandardusedinmanysystems since1995andisstillusedtoday.ItaddedcapabilitiesandimprovedontheoriginalATmotherboarddesign.
- Micro-ATX(MATX): ThisisasmallerversionoftheATXandisverypopularwithdesktopcomputers.Itisdesignedtobebackward-compatiblewiththeATXformfactorsothatitcanfitinanyATXcaseandhasthesamepowerconnectors.Becauseitissmaller,ithasfewerexpansionslots.
- ITX: ITXmotherboardsoriginatedwithVIAtechnologiesandcomeinseveraldifferentsmallformfactor(SFF)designs,includingmini-ITX,NANO-ITX,andPICO-ITX.TheyarereferredtoasembeddedboardsandconsumeverylittlepowercomparedtoATXbasedboards.Theydon’tneedtobecooledwithfans.
- Mini-ITX: Theseareenvisionedforuseinhometheatersystems.TheycanfitintoanycasebyusingstandardATXmountpoints.
- NANO-ITX: Thesesmallboardsaredesignedforsmallerdevicessuchasdigitalvideorecorders(DVRs)andset-topboxes.
- Pico-ITX: Theseextremelysmallboardscanbeembeddedindifferenttypesofmobiledevices.ThePico-ITXhasbeenadoptedasanopenstandardbytheSmallFormFactorSpecialInterestGroup,orSFF-SIG.

1.1.1.2) **Parts ofmotherboard;**

1) ***Miscellaneousconnectorsandjumpers:***Connectorsareavailabletoconnectaspeaker,tofans,andtothefontofthecaseforpoweranddisplays.Theycanbelocatedindifferentplacesonthemotherboard.
2) ***Expansionslots:***Expansionslotsallowyoutoaddadditionalcardstoamotherboardforadditionalcapabilities.Severaldifferenttypesofexpansionslotsareavailable,includingperipheralcomponentsInterconnect(PCI),acceleratedGraphicsPort(AGP),andmore.
3) ***Rareconnectors:***severalconnectorsareattachedtothemotherboardandareaccessibleviatherearofthecomputer.TheseincludeconnectorsforaudioandvideoUniversalSerialBus(USB)devicesandmore.Chapter5,"ExploringPeripheralandExpansionCards",discussescommonconnectors.
4) ***CPU12-Vpower:***A4-Pinplugfromthepowersupplyplugsintoheretoprovidepowertothe CentralProcessingUnit(CPU).OnsystemswithmultipleCPUs,thiscanbetwo4-pinplug.
5) ***CPUFan:***CPUsgeneratealotofheat,soit'scommontoattachafanontopofthem.Aconnectiononthemotherboardprovidespowerforthefan.CPUfansareoftenvariablespeedspthattheycanspinfasterwhentheCCPUgetshotter.
6) ***Chipset:***Thisconsistsofoneormoreintegratedcircuits(ICs)thatconnecttheCPUwithothercomponentsanddevicesonthesystem.ChipsetsaredesignedtoworkwithspecificCPUsandaresolderedintothemotherboard.Theycangethotandoftenhaveheatsinksontopofthemdesignedtodissipateheat.HeatsinksarediscussedinChapter3,“UnderstandingRAMandCPUs.”
7) ***CPU:***Themajorityofworkdonebyacomputeroccurswithintheprocessor.ThemotherboardincludesaCPUsocketintowhichaCPUisplugged,andtheCPUisnormallycoveredwithaheatsinkandacoolingfan.
8) ***SATAconnectors***:MostcomputerssupportSerialAdvancedTechnologyAttachment(SATA)drives.SATAconnectorshaveadistinctiveLshape.SATAconnectorscomeindifferentversions,andthesedifferentversionsareidentifiedwithdifferentcolors.However,thereisn’tastandardwiththecolorsbetweenmotherboardmanufacturers.Chapter4,“ComparingStorageDevices,”covershardiskdrives.
9) ***Battery:***ThebatteryprovidespowertotheBasicInput/OutputSystem(BIOS)sothatcertainsettingsareretained.Thebatteryisoftencircularbutcanhaveabarrelshape.

10) ***BIOSjumper:***Thereisoftenajumperclosetothebattery.ShortingthetwopinsonthisjumperwillresettheBIOSpasswordorreturntheBIOSsettingstothefactorydefaults.
11) ***RAM:***MotherboardsusuallyhaveatleasttwoRAMslots,andmanyhavefourorsix.RAMslotsareveryspecificandwillacceptonlycertaintypesofRAMbasedonthespecificationsofthemotherboard.Chapter3coversRAM.
12) ***IDEconnectors:***ExtendedIntegratedDriveElectronics(EIDE)connectorsareusedforEIDEdevicessuchasharddrivesandopticaldrives.ManysystemshavereplacedEIDEdriveswithSATAdrives,butyoustillmightseetheconnectors.Whentheboardincludesthem,you'llseetwoconnectorslabeledIDE1andIDE2,orsometimesIDE0andIDE1.
13) ***P1powerconnector:***Theprimarypowerconnectionfromthepowersupplyiseithera20-pinconnectorora24-pinconnector.14.Floppydriveconnector.Thisisfor3.5-inchfloppydrives.Theyareraretoday,butifthesystemhasafloppyconnector,itisusuallybytheIDEconnectors.
14) **Floppy drive connector:** This is for 3.5-inch floppy drives. They are rare today, but if the system has a floppy connector, it is usually by the IDE connectors.

1.1.1.3 System bus function: A bus within a computer refers to the connection between two or more components, and it is used to transfer data between these components. A computer has multiple busses that often work independently of each other. However, some busses work together. System bus are further divided into address bus, data bus and control bus.

Some functions of system bus are:

1. Carry data within the motherboard (Internal bus) or carry data to peripherals and other devices attached to motherboard (External bus).
2. Allow components to pass address to one another (Address Bus).
3. Send out signals to coordinate and manage the activities of the motherboard components (Control Bus).
4. Transfer data between peripherals, memory and CPU mainly.

1.1.1.3.1. Peripheral Component Interconnect (PCI) Local Bus:

PCI is interconnect or an expansion slot that allows high speed connection between peripherals, and from peripherals to the processor supporting plug and play. It also allows transfer of data amongst peripherals independently of the processor.

The Peripheral Component Interconnect (PCI) standard was a replacement for earlier industry standard architecture (ISA) and extended ISA expansion cards. It originally used a 32-bit data bus but was later improved to use a 64-bit bus. Table 2-2 shows the data rates and frequencies available with 32-bit and

64-bit versions of PCI.

TABLE 2-2 PCI Data Rates and Frequencies

Standard	Data Rate	Frequency
PCI (32-bit)	133 MB/s	33 MHz
PCI (32-bit)	266 MB/s	66 MHz
PCI (64-bit)	266 MB/s	33 MHz
PCI (64-bit)	533 MB/s	66 MHz

Tip: PCI cards Some PCI cards are created as universal cards with keying that can fit into either a 3.3-V or a 5-V slot. However, only 32-bit PCI cards can plug into 32-bit PCI slots and only 64-bit PCI cards can plug into 64-bit PCI slots.

Even though PCI has been largely replaced by PCIe, you will likely still see some PCI expansion slots on motherboards. The two versions have different slots, so it is easy to tell the difference between PCI and PCIe expansion slots and cards.

1.1.1.3.2. Accelerated Graphics Port (AGP)/PCI express

Accelerated Graphics Port (AGP) is a dedicated expansion slot used for graphics. A huge benefit of AGP over PCI was that it used a separate bus for graphics data so it wasn't competing with data from other expansion cards. Before AGP, graphics cards were plugged into a PCI slot and all PCI devices shared the same data bus. Graphics-intensive applications such as computer-aided design (CAD) applications and some games were extremely slow without AGP. AGP came in four versions, with each successive version doubling the data rate. Table 2-3 shows the data rates available with the different versions. Notice that AGP always uses a 66-MHz bus.

TABLE 2-3 AGP Data Rates and Frequencies

Standard	Data Rate	Frequency
AGP	266 MB/s	66 MHz
AGP 2X	533 MB/s	66 MHz
AGP 4X	1,066 MB/s	66 MHz
AGP 8X	2,133 MB/s	66 MHz

1.1.2. System BIOS

The Basic Input/output System (BIOS) includes software code that provides a computer with basic instructions so that it can start. When a computer is turned on, it runs the program within BIOS to do some basic system checks, locate the operating system on a disk, and start. In other words, BIOS (basic input/output system) is the program a personal computer's microprocessor uses to get the computer system started after you turn it on. It also manages data flow between the computer's operating system and attached devices such as the hard disk, video adapter, keyboard, mouse and printer.

The program within BIOS is stored in a chip on the computer that can be rewritten. Older computers used an electrically erasable programmable read-only memory chip (EEPROM) for the BIOS. Read-only memory (ROM) has gone through several iterations over the years, from programmable read-only memory (PROM), to erasable read-only memory (EPROM), and then to EEPROM. New computers use a type of flash memory similar to what is used with USB thumb drives.

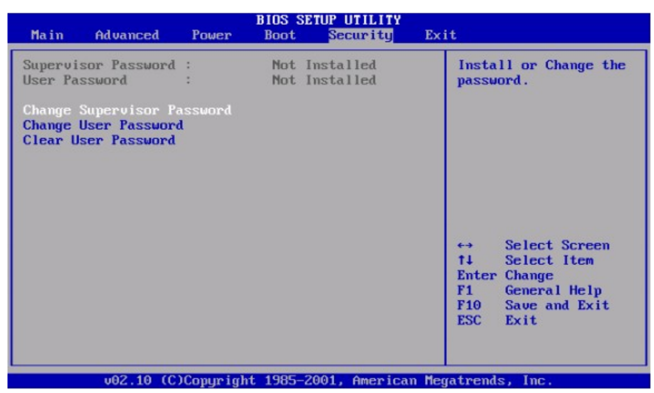
Moreover, it is different from CMOS

BIOS: This is the firmware. It stores the instructions for starting the computer and includes a program that can be used to change some settings. The firmware can be updated in a procedure referred to as flashing the BIOS (covered later in this chapter).

CMOS: This holds only the user-configurable BIOS settings, such as the current time. Users can change these settings by accessing the BIOS application. CMOS is volatile, meaning that the data is lost if the system is turned off. Motherboards include a CMOS battery to retain the CMOS data even if the system is turned off.

1.1.2.1. System BIOS Functions and Operation, BIOS Settings

Functions of bios are:



1. Check the CMOS Setup for custom settings

2. Load the interrupt handlers and device drivers

3. Initialize registers and power management

4. Perform the power-on self-test (POST)

5. Display system settings

6. Determine which devices are bootable

7. Initiate the bootstrap sequence

It allows us to verify different components installed on system. It helps to set configuration of boot sequence. It also configures all the system hardware with basic drivers so the system can get up and running. These drivers will set up and prepare the system memory and configure any peripheral devices for use such as the hard drives, optical drives, and video card.

The BIOS loads a basic system that's able to read the devices that contain the system operating system. BIOS initiate the operating system boot process after all the drivers are loaded and configured. The operating system contains more robust versions of the system drivers and replaces them with the BIOS versions once they're loaded.

One of the CMOS's most important role is it can alter the device boot process. This is important for system restoration because the CMOS may need to change boot priority from the hard drive to the optical drive or flash drive to launch the operating system installer or adjust which hard drive to load the operating system from. Furthermore, it also allows us to enable and disable devices.

Operation:

System Startup: If the system has just been powered up or the reset button was pressed (cold boot), the full power on self text (POST) is run. If ctrl + alt + delete was pressed (warm boot), a special flag value is stored in non volatile BIOS memory (CMOS) before processor is reset, and after the reset the BIOS startup code detects this flag and does not run POST. This saves the time otherwise used to detect and test all memory.

The POST checks, identifies, and initializes system devices such as CPU, RAM, interrupt and DMA controllers and other parts of the chipset, video display card, keyboard, hard disk drive, optical disk drive and other basic hardware.

Boot process:

After the option immediately after POST in BIOS version that does not scan for option (derived from wikipedia)

Incomplete

The Processor:

A central processing unit (CPU) is the electronic circuitry within a computer that carries out the instructions of a computer program by performing the basic arithmetic, logical, control and input/output (I/O) operations specified by the instructions. The computer industry has used the term "central processing unit" at least since the early 1960s.[1] Traditionally, the term "CPU" refers to a processor, more specifically to its processing unit and control unit (CU), distinguishing these core elements of a computer from external components such as main memory and I/O circuitry.

Principal components of a CPU include the arithmetic logic unit (ALU) that performs arithmetic and logic operations, processor registers that supply operands to the ALU and store the results of ALU operations, and a control unit that orchestrates the fetching (from memory) and execution of instructions by directing the coordinated operations of the ALU, registers and other components.

Most modern CPUs are microprocessors, meaning they are contained on a single integrated circuit (IC) chip. An IC that contains a CPU may also contain memory, peripheral interfaces, and other components of a computer; such integrated devices are variously called microcontrollers or systems on a chip (SoC). Some computers employ a multi-core processor, which is a single chip containing two or more CPUs called "cores"; in that context, one can speak of such single chips as "sockets".

1.2.1.1. Processor Power and Voltage

The CPU core voltage (V_{CORE}) is the power supply voltage supplied to the CPU (which is a digital circuit), GPU, or other device containing a processing core. The amount of power a CPU uses, and thus the amount of heat it dissipates, is the product of this voltage and the current it draws. In modern CPUs, which are made using CMOS, the current is almost proportional to the clock speed, the CPU drawing almost no current between clock cycles. (See, however, subthreshold leakage.

1.2.1.2. Processor Cooling

A CPU cooler is device designed to draw heat away from the system CPU and other components in the enclosure. Using a CPU cooler to lower CPU temperatures improves efficiency and stability of the system. Adding a cooling device, however, can increase the overall noise level of the system. It has two types:

Air CPU Coolers

The CPU cooler may consist of a heat sink (a component designed to lower the temperature of an electronic device by dissipating heat into the surrounding air) or combination of a heat sink and fan. These cooling systems are generally referred to as air cooling and are often used in conjunction with systems that are designed to improve airflow.

Liquid CPU Cooling

Another type of CPU cooling is called liquid cooling, where liquid circulates liquid through small pipes in a heat sink, drawing heat from the CPU to a dedicated radiator located on the system case or enclosure, where it is released into the ambient air outside of the system. The cooled liquid travels back through the system to the CPU to continue the process.

Other Cooling Methods

Other CPU cooling methods include software cooling where software is used to access and control the CPU's power-saving technology.

1.2.1.3. Processor Sockets and Slots

In computer hardware, a CPU socket or CPU slot comprises one or more mechanical components providing mechanical and electrical connections between a microprocessor and a printed circuit board (PCB). This allows for placing and replacing the central processing unit (CPU) without soldering.

Common sockets have retention clips that apply a constant force, which must be overcome when a device is inserted. For chips with a large number of pins, either zero insertion force (ZIF) sockets or land grid array (LGA) sockets are used instead. These designs apply a compression force once either a handle (for ZIF type) or a surface plate (LGA type) is put into place. This provides superior mechanical retention while avoiding the risk of bending pins when inserting the chip into the socket.

CPU sockets are used on the motherboard in desktop and server computers. As they allow easy swapping of components, they are also used for prototyping new circuits. Laptops typically use surface-mount CPUs, which take up less space on the motherboard than a socketed part.

Furthermore, A CPU socket is made of plastic, and comes with a lever or latch, and with metal contacts for each of the pins or lands on the CPU. Many packages are keyed to ensure the proper insertion of the CPU. CPUs with a PGA (pin grid array) package are inserted into the socket and the latch is closed. CPUs with an LGA package are inserted into the socket, the latch plate is flipped into position atop the CPU, and the lever is lowered and locked into place, pressing the CPU's contacts firmly against the socket's lands and ensuring a good connection, as well as increased mechanical stability.

1.2.2. System Memory, Memory Technology Types, Speed, Size

The computer memory is a temporary storage area. It holds the data and instructions that the Central Processing Unit (CPU) needs. Before a program can be run, the program is loaded from some storage medium into the memory. This allows the CPU direct access to the program. Memory is a need for any computer.

A computer is usually an electrical device, which understands only electricity on and electricity off. This is expressed by using two symbols – 0 and 1 – which are called binary digits or bits. Numbers and text characters are represented as codes, which are made up of combinations of 0s and 1s. Simple character codes are called ASCII (the American Standard Code for Information Interchange), and Unicode. In ASCII, eight bits – any combination of 0s and 1s – form one character or symbol. For example, the letter A is denoted by the code 01000001. The basic working unit of the computer's memory is a group of eight bits, which is called a byte. It can be divided into two primary types:

Read only memory

There are some programs and instructions which the computer will always need. Read only memory (ROM) is the permanent memory which is used to store these important control programs and systems software to perform a variety of functions, such as booting up or starting up programs. ROM is non-volatile. That means the contents are not lost when the power is switched off. Its contents are written at the time of manufacture, but in modern (2012) computers may be changed using special software.

Random access memory

Random access memory (RAM) is used as the working memory of a computer system. It stores input data, intermediate results, programs, and other information temporarily. It can be read and/or written. It is usually volatile, that is all data will be lost when the power is turned off. In most cases it is loaded again from hard disk which is used as data storage.

Memory technology

A Memory Technology Device (MTD) is a type of device file in Linux for interacting with flash memory. The MTD subsystem was created to provide an abstraction layer between the hardware-specific device drivers and higher-level applications. Although character and block device files already existed, their semantics don't map well to the way that flash memory devices operate.

For additional studies:

Semiconductor memory technologies

There is a large variety of types of ROM and RAM that are available. These arise from the variety of applications and also the number of technologies available. This means that there is a large number of abbreviations or acronyms and categories for memories ranging from Flash to MRAM, PROM to EEPROM, and many more:

- ***PROM:*** This stands for Programmable Read Only Memory. It is a semiconductor memory which can only have data written to it once - the data written to it is permanent. These memories are bought in a blank format and they are programmed using a special PROM programmer. Typically a PROM will consist of an array of fuseable links some of which are "blown" during the programming process to provide the required data pattern.

- ***EPROM:*** This is an Erasable Programmable Read Only Memory. This form of semiconductor memory can be programmed and then erased at a later time. This is normally achieved by exposing the silicon to ultraviolet light. To enable this to happen there is a circular window in the package of the EPROM to enable the light to reach the silicon of the chip. When the PROM is in use, this window is normally covered by a label, especially when the data may need to be preserved for an extended period.

  The PROM stores its data as a charge on a capacitor. There is a charge storage capacitor for each cell and this can be read repeatedly as required. However it is found that after many years the charge may leak away and the data may be lost. Nevertheless, this type of semiconductor memory used to be widely used in applications where a form of ROM was required, but where the data needed to be changed periodically, as in a development environment, or where quantities were low.

- ***EEPROM:*** This is an Electrically Erasable Programmable Read Only Memory. Data can be written to it and it can be erased using an electrical voltage. This is typically applied to an erase pin on the chip. Like other types of PROM, EEPROM retains the contents of the memory even when the power is turned off. Also like other types of ROM, EEPROM is not as fast as RAM. Read more about EEPROM

- ***Flash memory:*** Flash memory may be considered as a development of EEPROM technology. Data can be written to it and it can be erased, although only in blocks, but data can be read on an individual cell basis. To erase and re-programme areas of the chip, programming voltages at levels that are available within electronic equipment are used. It is also non-volatile, and this makes it particularly useful. As a result Flash memory is widely used in many applications including memory cards for digital cameras, mobile phones, computer memory sticks and many other applications. Read more about Flash memory

- ***DRAM:*** Dynamic RAM is a form of random access memory. DRAM uses a capacitor to store each bit of data, and the level of charge on each capacitor determines whether that bit is a logical 1 or 0. However these capacitors do not hold their charge indefinitely, and therefore the data needs to be refreshed periodically. As a result of this dynamic refreshing it gains its name of being a dynamic RAM. DRAM is the form of semiconductor memory that is often used in equipment including personal computers and workstations where it forms the main RAM for the computer. Read more about DRAM

- ***SRAM:*** Static Random Access Memory. This form of semiconductor memory gains its name from the fact that, unlike DRAM, the data does not need to be refreshed dynamically. It is able to support faster read and write times than DRAM (typically 10 ns against 60 ns for DRAM), and in addition its cycle time is much shorter because it does not need to pause between accesses. However it consumes more power, is less dense and more expensive than DRAM. As a result of this it is normally used for caches, while DRAM is used as the main semiconductor memory technology. Read more about SRAM

- ***SDRAM:*** Synchronous DRAM. This form of semiconductor memory can run at faster speeds than conventional DRAM. It is synchronised to the clock of the processor and is capable of keeping two sets of memory addresses open simultaneously. By transferring data alternately from one set of addresses, and then the other, SDRAM cuts down on the delays associated with non-synchronous RAM, which must close one address bank before opening the next. Read more about SDRAM

- ***MRAM:*** This is Magneto-resistive RAM, or Magnetic RAM. It is a non-volatile RAM memory technology that uses magnetic charges to store data instead of electric charges. Unlike technologies including DRAM, which require a constant flow of electricity to maintain the integrity of the data, MRAM retains data even when the power is removed. An additional advantage is that it only requires low power for active operation. As a result this technology could become a major player in the electronics industry now that production processes have been developed to enable it to be produced. Read more about MRAM

- ***P-RAM / PCM:*** This type of semiconductor memory is known as Phase change Random Access Memory, P-RAM or just Phase Change memory, PCM. It is based around a phenomenon where a form of chalcogenide glass changes is state or phase between an amorphous state (high resistance) and a polycrystalline state (low resistance). It is possible to detect the state of an individual cell and hence use this for data storage. Currently this type of memory has not been widely commercialised, but it is expected to be a competitor for flash memory. Read more about P-RAM / PCM

- ***F-RAM:*** Ferroelectric RAM is a random-access memory technology that has many similarities to the standard DRAM technology. The major difference is that it incorporates a ferroelectric layer instead of the more usual dielectric layer and this provides its non-volatile capability. As it offers a non-volatile capability, F-RAM is a direct competitor to Flash. Read more about F-RAM

Memory size:

A byte is a sequence of 8 bits (enough to represent one alphanumeric character) processed as a single unit of information. A single letter or character would use one byte of memory (8 bits), two characters would use two bytes (16 bits).

Put another way, a bit is either an 'on' or an 'off' which is processed by a computer processor, we represent 'on' as '1' and 'off' as '0'. 8 bits are known as a byte, and it is bytes which are used to pass our information in it's basic form - characters.

An alphanumeric character (e.g. a letter or number such as 'A', 'B' or '7') is stored as 1 byte. For example, to store the letter 'R' uses 1 byte, which is stored by the computer as 8 bits, '01010010'.

A document containing 100 characters would use 100 bytes (800 bits) - assuming the file didn't have any overhead (additional data about the file which forms part of the file). Note, many non-alphanumeric characters such as symbols and foreign language characters use multiple bytes.

1024 bytes	=	**1 KB**
1024 KB	=	**1 MB**
1024 MB	=	**1 GB**
1024 GB	=	**1 TB**
1024 TB	=	**1 PB**

KB	=	**Kilobyte**
MB	=	**Megabyte**
GB	=	**Gigabyte**
TB	=	**Terabyte**
PB	=	**Petabyte**

A kilobyte (KB) is 1024 bytes, a megabyte (MB) is 1024 kilobytes and so on as these tables demonstrate.

Memory speed

The speed of the memory will determine the rate at which the CPU can process data. The higher the clock rating on the memory, the faster the system is able to read and write information from the memory. All memory is rated at a specific clock rate in megahertz that the memory interface talks to the CPU with. Newer memory classifying methods are now starting to refer to them based on the theoretical data bandwidth that the memory supports which can be confusing.

Further:

All the versions of DDR memory are referred to by the clock rating, but more frequently memory manufacturers are starting to refer to the bandwidth of the memory. To make things confusing, these memory types can be listed in two ways. The first method lists the memory by its overall clock speed and the version of DDR that is used. For instance, you may see mention of 1600MHz DDR3 or DDR3-1600 which essentially is just the type and the speed combined.

The other method of classifying the modules is by their bandwidth rating in megabytes per second. 1600MHz memory can run at a theoretically speed of 12.8 gigabytes per second or 12,800 megabytes per second. This is then prepended by the version number appended to PC. Thus DDR3-1600 memory is also referred to as PC3-12800 memory. Here is a short conversion of some of the standard DDR memory that can be found:

DDR3-1066 = PC3-8500

DDR3-1333 = PC3-10600

DDR3-1600 = PC3-12800

DDR4-2133 = PC4-17000

DDR4-2666 = PC4-21300

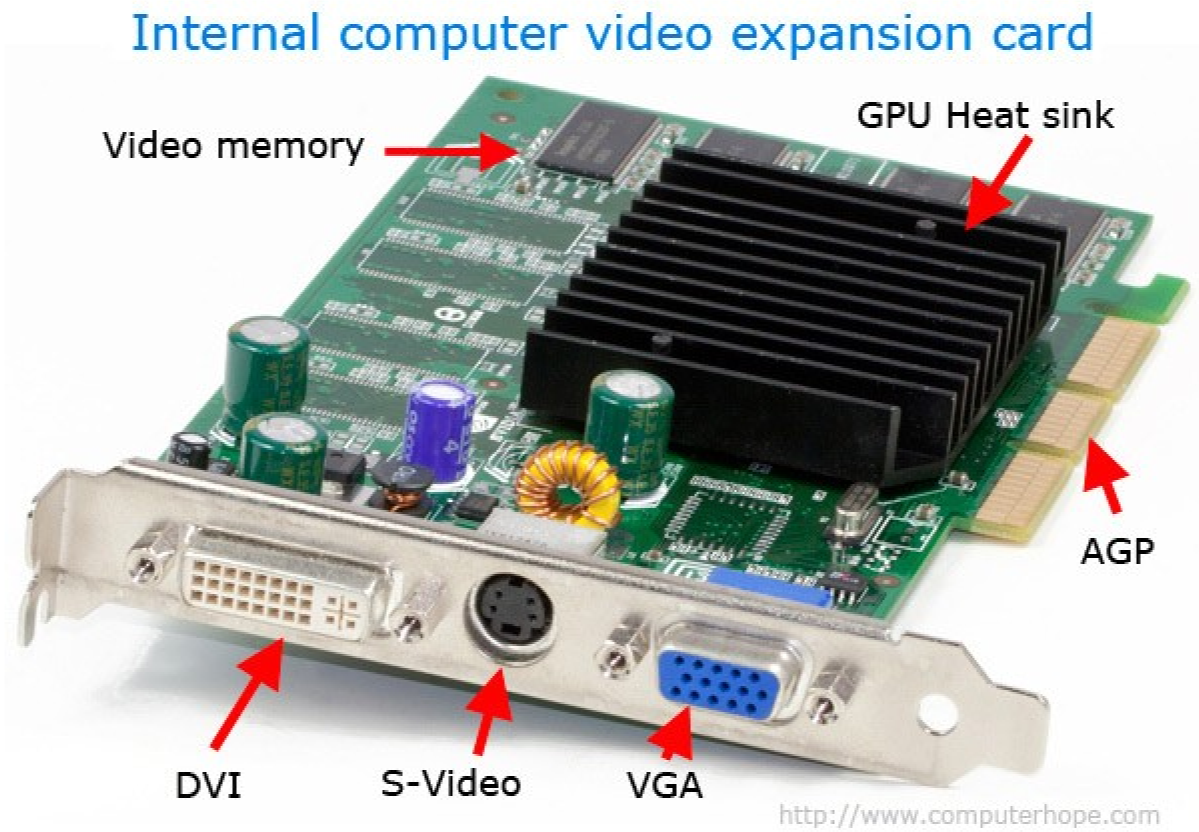
DDR4-3200 = PC4-25600

Latency

For memory there is another factor that impacts the performance, latency. This is the amount of time (or clock cycles) it takes the memory to respond to a command request.

1.2. Video Cards

Alternatively known as a display adapter, graphics card, video adapter, video board, or video controller, a video card is an IC or internal board that creates a picture on a display. Without a video card, you would not be able to see this page.



Video card ports

The picture above is an example of a video card with three connections, or video ports, on the back.

- VGA connector
- S-Video connector
- DVI connector

In the past, VGA or SVGA was the most popular connection used with computer monitors. Today, most flat panel displays use the DVI connector or HDMI connector (not pictured above).

Video card expansion slots

In the picture above, the video card is inserted into the AGP expansion slot on the computer motherboard. Over the development of computers, there have been several types of expansion slots used for video cards. Today, the most common expansion slot for video cards is PCIe, which replaced AGP, which replaced PCI, which replaced ISA.

1.3.1. Video Modes, Resolution and Color

Video mode

The video mode is the mode that a video adapter is currently running. For example, in graphics mode, the video card or display device is capable of displaying graphics. However, in text mode, the display only displays text. Each mode is capable of different maximum resolution and maximum colors.

Resolution

Resolution is the image quality produced by a printer or displayed on a monitor. With monitors, the resolution is measured by the number of pixels horizontal by pixels vertically as shown in the picture. Printers also have a measure of resolution called DPI (dots per inch).

When resolution increases, images become crisper due to a higher pixel density. In fact, text and images may also become smaller because more pixels per square inch are being displayed.

The opposite of what happens when you increase the resolution; text should appear bigger, images are not as crisp, and performance requirements go down.

Common widescreen resolutions

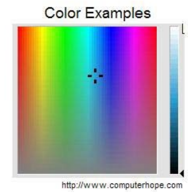
Monitor size	Resolution
19-inch	1680 x 1050
21-inch	1920 x 1080
23-inch	1920 x 1080 to 2560 x 1440
27-inch	2560 x 1440 to 3840 x 2160

Common Ultra Wide resolutions

Monitor size	Resolution
25-inch	2560 x 1080
29-inch	2560 x 1080
34-inch	2560 x 1080 to 3440 x 1440,

Color

In general, color or colour refers to a human interaction between the eye and a spectrum of light that creates a wide variety of different colors such as red, blue, yellow, and green. The picture is an example of a custom color picker.



Video display standards

Video display standards have evolved from early monochrome to today's high resolution color. The evolution of these standards is summarized here.

Initial video standards were developed by IBM as one of the only players in the PC marketplace. As IBM's influence over the hardware waned (or got diluted, whichever viewpoint you care to take) the Video Electronics Standards Association (VESA) was formed to define new standards for computer video displays.

Some main types of VDS are:

Monochrome Display Adapter (MDA)

Introduced in 1981, MDA was a pure text display showing 80 character lines with 25 vertical lines on the screen. Typically, the display was green text on a black background. Individual characters were 9 pixels wide by 14 pixels high (7×11 for the character, the rest for spacing). If you multiply that out you get a resolution of 720×350 but since the individual pixels were not capable of being addressed there were no graphics. Although, some programs managed some interesting bar charts and line art using various ASCII characters; particularly those above 128 used by code page 437.

The IBM MDA card had 4 KB of video memory. Display attributes included: invisible, underline, normal, bright/bold, reverse video, and blinking. Some attributes could be combined. IBM graphic's card also contained a parallel printer port giving it the full name: *Monochrome Display and Printer Adapter*.

The monitor's refresh rate was 50 Hz and users tended to complain about eyestrain after long days in front of the monitor.

Hercules Graphics Card

Noting the 720×350 resolution of the MDA display, a company called Hercules Computer Technology (founded by Van Suwannukul), in 1982, developed an MDA-compatible video card that could display MDA text as well as graphics by having routines to individually address each pixel in the display. Because the screen height had to be a multiple of four, the full resolution of the Hercules Graphics Card was 720×348.

Color Graphics Adapter (CGA)

IBM came back to the fore when color started to appear in computer displays. The CGA standard, introduced in 1981 and primative by today's standards, was still color; even if only 16 of them. Because the first PCs were for business, the color did not first catch on and the MDA monochrome standard we more often used. As prices came down and clones of the IBM PC were introduced, CGA became more of a standard.

The CGA card came with 16 KB of video memory and supported several different modes:

- **Text mode** which included 80×25 text (like the MDA system) in 16 colors. The resolution, however was lower as each character was made up of 8×8 pixels instead of the MDA's 9×14 pixels. A 40×25 text mode was also supported in 16 colors. In both, the foreground and background colors could be changed for each character.
- **Monochrome graphics mode** which displayed graphics at 640×200 pixels. This was lower than the Hercules card but seemed to serve the purpose for an initial release and this was quickly replaced with the EGA standard.
- **Color graphics mode** which came in two flavors: a 320×200 pixel mode with four colors and a lesser-used resolution of 160×200 in 16 colors. The four-color mode only had two official palettes to choose from:
    - Magenta, cyan, white and background color (black by default).
    - Red, green, brown/yellow and background color (black by default).

Enhanced Graphics Adapter

The Enhanced Graphics Adapter was introduced by IBM in 1984 as the primary display for the new PC-AT Intel 286-based computer. EGA increased resolution to 640×350 pixels in 16 colors. The card itself contained 16 KB of ROM to extend the system BIOS to add graphics functions. The card started with 64 KB of video memory but later cards and clone cards came with 256KB of video memory to allow full implementation of all EGA modes which included…

- **High-resolution mode** with 640×350 pixel resolution. On any given screen display a total of 16 colors could be displayed; however, these could be selected from a palette of 64 colors.
- **CGA mode** included full 16-color versions of the CGA 640×200 and 320×200 graphics modes. The original CGA modes were present in the card but EGA is not 100% hardware-compatible with CGA.
- **MDA** could be supported to some degree. By setting switches on the card an MDA monitor could be driven by an EGA card however only the 640×350 display could be supported.

1.4.1. Construction and Operation of the Hard Disk Drive

Construction

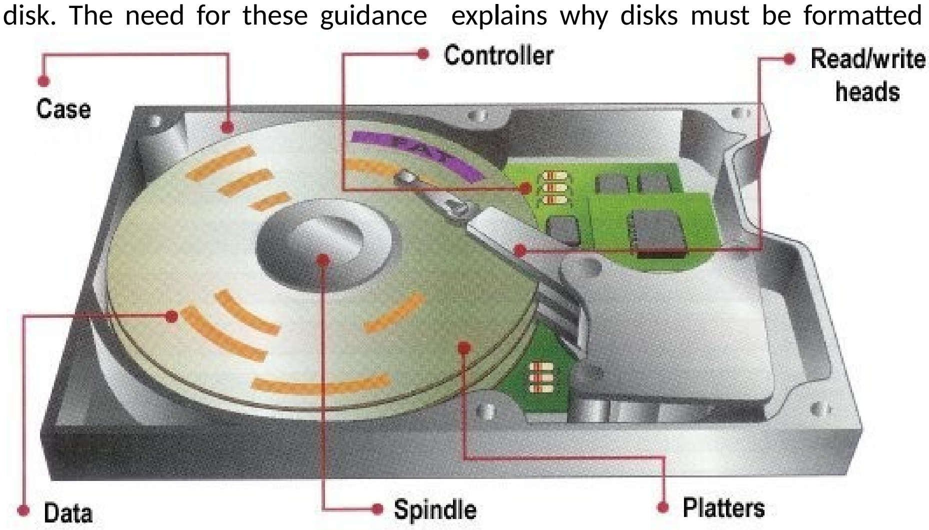
Hard disks are rigid platters, composed of a substrate and a magnetic medium. The substrate – the platter's base material – must be non-magnetic and capable of being machined to a smooth finish. It is made either of aluminum alloy or a mixture of glass and ceramic. To allow data storage, both sides of each platter are coated with a magnetic medium – formerly magnetic oxide, but now, almost exclusively, a layer of metal called a thin-film medium. This stores data in magnetic patterns, with each platter capable of storing a billion or so bits per square inch (bpsi) of platter surface.

Platters vary in size and hard disk drives come in two form factors, 5.25in or 3.5in. The trend is towards glass technology since this has the better heat resistance properties and allows platters to be made thinner than aluminium ones. The inside of a hard disk drive must be kept as dust-free as the factory where it was built. To eliminate internal contamination, air pressure is equalised via special filters and the platters are hermetically sealed in a case with the interior kept in a partial vacuum. This sealed chamber is often referred to as the head disk assembly (HDA).

Operation

The disc platters are mounted on a single spindle that spins at a typical 10,000rpm. On EIDE and SCSI drives the disk controller is part of the drive itself. It controls the drive's servo-motors and translates the fluctuating voltages from the head into digital data for the CPU.

Data is recorded onto the magnetic surface of a platter in exactly the same way as it is on floppies or digital tapes. Essentially, the surface is treated as an array of dot positions, with each domain' of magnetic polarization being set to a binary 1 or 0. The position of each array element is not identifiable in an absolute sense, and so a scheme of guidance marks helps the read/write head find positions on the disk. The need for these guidance explains why disks must be formatted before they can be used.



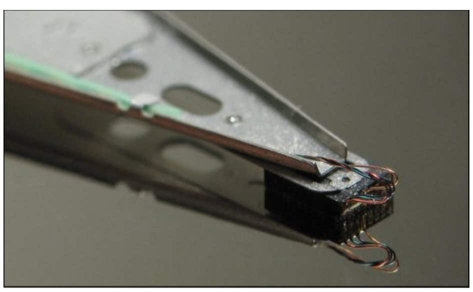
When it comes to accessing data already stored, the disk spins round very fast so that any part of its circumference can be quickly identified. The drive translates a read request from the computer into reality. There was a time when the cylinder/head/sector location that the computer worked out really was the data's location, but today's drives are more complicated than the BIOS can handle, and they translate BIOS requests by using their own mapping.

1.4.1.1. Hard Disk Geometry, Tracks, Cylinders and Sectors

Hard Disk Geometry

Typically two, three or more platters are stacked on top of each other with a common spindle that turns the whole assembly at several thousand revolutions per minute. There's a gap between the platters, making room for magnetic read/write head, mounted on the end of an actuator arm. This is so close to the platters that it's only the rush of air pulled round by the rotation of the platters that keeps the head away from the surface of the disk – it flies a fraction of a millimetre above the disk. On early hard disk drives this distance was around 0.2mm. In modern-day drives this has been reduced to 0.07mm or less. A small particle of dirt could cause a head to crash, touching the disk and scraping off the magnetic coating. On IDE and SCSI drives the disk controller is part of the drive itself.

There's a read/write head for each side of each platter, mounted on arms which can move them towards the central spindle or towards the edge. The arms are moved by the head actuator, which contains a voice-coil – an electromagnetic coil that can move a magnet very rapidly. Loudspeaker cones are vibrated using a similar mechanism.



The heads are designed to touch the platters when the disk stops spinning – that is, when the drive is powered off. During the spin-down period, the airflow diminishes until it stops completely, when the head lands gently on the platter surface – to a dedicated spot called the landing zone (LZ). The LZ is dedicated to providing a parking spot for the read/write heads, and never contains data.

Track

A disk drive track is a circular path on the surface of a disk or diskette on which information is magnetically recorded and from which recorded information is read.

A track is a physical division of data in a disk drive, as used in the Cylinder-Head-Record (CCHHRR) addressing mode of a CKD disk. The concept is concentric, through the physical platters, being a data circle per each cylinder of the whole disk drive. In other words, the number of tracks on a single surface in the drive exactly equals the number of cylinders of the drive.

Cylinder

A cylinder is a division of data in a disk drive, as used in the CHS addressing mode of a Fixed Block Architecture disk or the cylinder–head–record (CCHHR) addressing mode of a CKD disk.

The concept is concentric, hollow, cylindrical slices through the physical disks (platters), collecting the respective circular tracks aligned through the stack of platters. The number of cylinders of a disk drive exactly equals the number of tracks on a single surface in the drive. It comprises the same track number on each platter, spanning all such tracks across each platter surface that is able to store data (without regard to whether or not the track is "bad"). Cylinders are vertically formed by tracks. In other words, track 12 on platter 0 plus track 12 on platter 1 etc. is cylinder 12.

Sector

In computer disk storage, a sector is a subdivision of a track on a magnetic disk or optical disc. Each sector stores a fixed amount of user-accessible data, traditionally 512 bytes for hard disk drives (HDDs) and 2048 bytes for CD-ROMs and DVD-ROMs. Newer HDDs use 4096-byte (4 KiB) sectors, which are known as the Advanced Format (AF).

The sector is the minimum storage unit of a hard drive.[1] Most disk partitioning schemes are designed to have files occupy a multiple of sectors regardless of the file's actual size. Files that do not fill a whole sector will have the remainder of their last sector filled with zeroes. In practice, operating systems typically operate on blocks of data, which may span multiple sectors.[2]

Geometrically, the word sector means a portion of a disk between a center, two radii and a corresponding arc (see Figure 1, item B), which is shaped like a slice of a pie. Thus, the disk sector (Figure 1, item C) refers to the intersection of a track and geometrical sector.

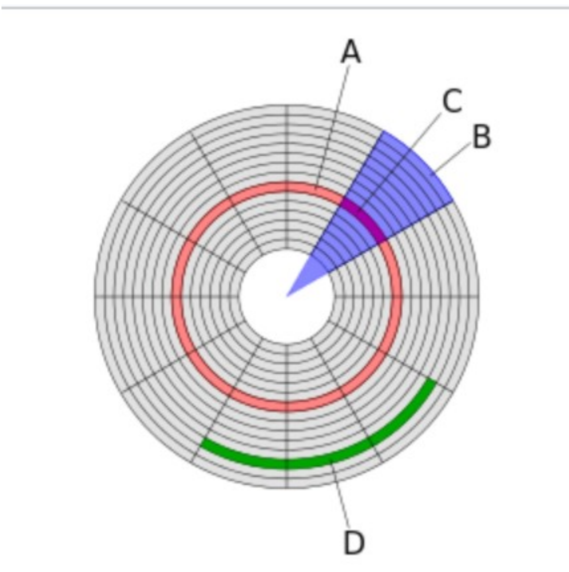
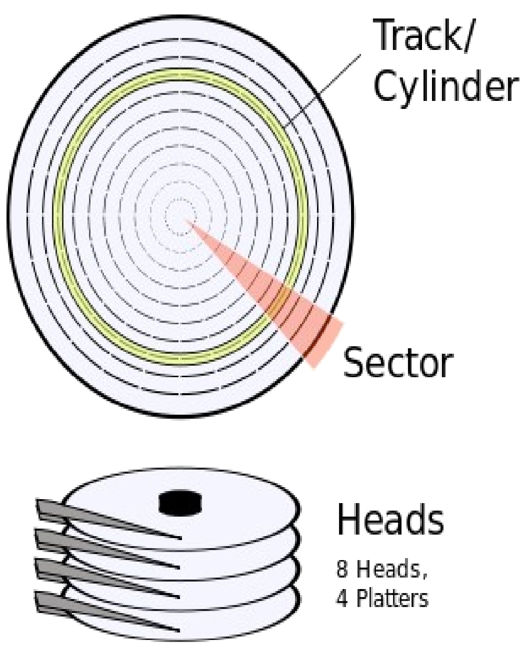


Figure 1: Disk structures:

- A. Track
- B. Geometrical sector
- C. Track sector
- D. Cluster



Partitioning hard disk

Disk partitioning or disk slicing[1] is the creation of one or more regions on a hard disk or other secondary storage, so that an operating system can manage information in each region separately.[2] Partitioning is typically the first step of preparing a newly manufactured disk, before any files or directories have been created. The disk stores the information about the partitions' locations and sizes in an area known as the partition table that the operating system reads before any other part of the disk. Each partition then appears in the operating system as a distinct "logical" disk that uses part of the actual disk. System administrators use a program called a partition editor to create, resize, delete, and manipulate the partitions.[3]When a hard drive is installed in a computer, it must be partitioned before you can format and use it. Partitioning a drive is when you divide the total storage of a drive into different pieces. These pieces are called partitions. Once a partition is created, it can then be formatted so that it can be used on a computer.

Partitioning Size
For Advanced Format 4K Native drives (4-KB-per-sector) drives, the minimum partition size is 260 MB, due to a limitation of the FAT32 file format. The minimum partition size of FAT32 drives is calculated as sector size (4KB) x 65527 = 256 MB. For more information, see Configure UEFI/GPT-Based Hard Drive Partitions.

Drive lettering
In computer data storage, drive letter assignment is the process of assigning alphabetical identifiers to volumes. Unlike the concept of UNIX mount points, where volumes are named and located arbitrarily in a single hierarchical namespace, drive letter assignment allows multiple highest-level namespaces. Drive letter assignment is thus a process of using letters to name the roots of the "forest" representing the file system; each volume holds an independent "tree" (or, for non-hierarchical file systems, an independent list of files).

Applying the scheme discussed above on a fairly modern Windows-based system typically results in the following drive letter assignments:

- A: — Floppy disk drives, 3.5" or 5.25", and possibly other types of disk drives, if present.
- B: — Reserved for a second floppy drive, if present.
- C: — First hard disk partition.
- D: to Z: — other disk partitions get labeled here. Windows assigns the next free drive letter to the next drive it encounters while enumerating the disk drives on the system.

1.4.1.3. Formatting and Capacity

Capacity

The primary characteristics of an HDD are its capacity and performance. Capacity is specified in unit prefixes corresponding to powers of 1000: a 1-terabyte (TB) drive has a capacity of 1,000 gigabytes (GB; where 1 gigabyte = 1 billion bytes). Typically, some of an HDD's capacity is unavailable to the user because it is used by the file system and the computer operating system, and possibly inbuilt redundancy for error correction and recovery. Performance is specified by the time required to move the heads to a track or cylinder (average access time) plus the time it takes for the desired sector to move under the head (average latency, which is a function of the physical rotational speed in revolutions per minute), and finally the speed at which the data is transmitted (data rate)

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. In some cases, the formatting operation may also create one or more new file systems. The first part of the formatting process that performs basic medium preparation is often referred to as "low-level formatting".[1] Partitioning is the common term for the second part of the process, making the data storage device visible to an operating system.[1] The third part of the process, usually termed "high-level formatting" most often refers to the process of generating a new file system.[1] In some operating systems all or parts of these three processes can be combined or repeated at different levels[nb 1] and the term "format" is understood to mean an operation in which a new disk medium is fully prepared to store files

1.4.2. Hard Disk Interfaces and Configuration

1.4.2.1. Interface: IDE/ATA/ATAPI, SATA, USB

USB:

Short for **Universal Serial Bus**, **USB** (pronounced yoo-es-bee) is a plug-and-play interface that allows a computer to communicate with peripheral and other devices. USB-connected devices cover a broad range; anything from keyboards and mice, to music players and flash drives. For more information on these devices, see our USB devices section.

USB may also be used to send power to certain devices, such as smartphones and tablets, as well as charge their batteries. The first commercial release of the Universal Serial Bus (version 1.0) was in January of 1996. This industry standard was then quickly adopted by Intel, Compaq, Microsoft and other companies.

IDE:

IDE (Integrated Drive Electronics) is a standard electronic interface used between a computer motherboard's data paths or bus and the computer's disk storage devices. The IDE interface is based on the IBM PC Industry Standard Architecture (ISA) 16-bit bus standard, but it is also used in computers that use other bus standards. IDE was adopted as a standard by the American National Standards Institute (ANSI) in November 1990.

ATA:

Short for **Advanced Technology Attachment**, **ATA** was approved May 12, 1994 and is an interface that connects hard drives, CD-ROM drives, and other drives. The first ATA interface is now commonly referred to as **PATA**, which is short for **Parallel AT Attachment** after the introduction of **SATA**. Today, almost all home computers use the ATA interface, including Apple computers, which use SATA.

The ATA standard is backward compatible, which means new ATA drives (excluding SATA) can be used with older ATA interfaces.

ATAPI:

ATAPI (AT Attachment Packet Interface) is an interface between your computer and attached CD-ROM drives and tape backup drives. Most of today's PC computers use the standard Integrated Drive Electronics (IDE) interface to address hard disk drives. ATAPI provides the additional commands needed for controlling a CD-ROM player or tape backup so that your computer can use the IDE interface and controllers to control these relatively newer device types.

SATA:

Short for **SerialATA**, **SATA** 1.0 was first released in August 2001 and is a replacement for the Parallel ATA interface used in IBM compatible computers. SerialATA is capable of delivering 1.5 Gbps (1500 MBps) of performance to each drive within a disk array. It has the benefit of being backwards-compatible with ATA and ATAPI devices, and offers a thin, small cable solution, as seen in the photo on the right. This cable helps make a much easier cable routing and offers better airflow in the computer when compared to the earlier ribbon cables used with ATA drives.

SATA also supports external drives through **External SATA** more commonly known as **eSATA**. eSATA offers many more advantages when compared to other solutions. For example, it is hot-swappable, supports faster transfer speeds with no bottleneck issues like USBand FireWire, and supports disk drive technologies such as S.M.A.R.T..

However, eSATA does have some disadvantages such as not distributing power through the cable like USB, which means drives require an external power source. The eSATA cable also supports a maximum length of up to 2 meters. Because of these disadvantages don't plan on eSATA becoming the only external solution for computers.

1.5. CD, DVD-ROM Drives and Interfaces

Abbreviated as **CD**, a **compact disc** is a flat, round, optical storage medium invented by James Russell. The first CD was created at a Philips factory in Germany on August 17, 1982. The picture is an example of the bottom of a standard compact disc and is the side the disc player reads. The opposite side of the disc has a label to help indicate what is on the disc.

Short for **Digital Versatile Disc** or **Digital Video Disc**, a **DVD** or **DVD-ROM** is a disc capable of storing large amounts of data on one disc the size of a standard Compact Disc. **CD/DVD drives** were first sold in 1997. They are widely used for storing and viewing movies and other data. To play DVDs on a computer, you must have a DVD drive and a software DVD player. The picture to the right is an example of what a DVD movie may look like, which in this example is a picture of the Matrix DVD movie.

The interfaces used in CD, DVD-ROM Drives are

1.5.1. CD, DVD-ROM Drive Construction and Operation

????????????????Incomplete???????????????????

1.5.2. Recordable CD (CD-R)

CD-R (**Compact Disc-Recordable**) is a digital optical disc storage format. A CD-R disc is a compact disc that can be written once and read arbitrarily many times.

CD-R discs (CD-Rs) are readable by most plain CD readers, i.e., CD readers manufactured prior to the introduction of CD-R. This is an advantage over CD-RW, which can be re-written but cannot be played on many plain CD readers.

1.5.3. Rewriteable CD (CD-RW)

CD-RW (Compact Disc-ReWritable) is a digital optical disc storage format. A CD-RW disc is a compact disc that can be written, read arbitrarily many times, erased, and written again. The technology was introduced in 1997.

CD-RW discs (CD-RWs) require readers that have more sensitive laser optics than are required to read plain CDs. Consequently, CD-RWs cannot be read in many CD readers built prior to the introduction of CD-RW. CD-ROM drives that bear a "MultiRead" certification claim compatibility.

CD-RW discs need to be blanked before reuse. Different blanking methods can be used, including "full" blanking in which the entire surface of the disc is cleared, and "fast" blanking in which only metadata areas are cleared: PMA, TOC and pregap, comprising a few percent of the disc. Fast blanking is much quicker, and is usually sufficient to allow rewriting the disc. Full blanking removes traces of the former data, often for confidentiality reasons. It may be possible to recover data from full-blanked CD-RWs with specialty data recovery equipment

1.6.1. Monitor Resolution, Colour and Refresh rate *

	14"	15"	17"	19"	21"
640x480	**BEST**	GOOD	TOO BIG	HUGE	TERRIBLE
800x600	GOOD	**BEST**	GOOD	TOO BIG	HUGE
1024x768	TOO SMALL	GOOD	**BEST**	GOOD	STILL GOOD
1280x1024	TINY	TOO SMALL	GOOD	**BEST**	GOOD
1600x1200	TERRIBLE	TINY	TOO SMALL	GOOD	**BEST**

A computer monitor is made of pixels (short for "picture element"). Monitor resolution is measured in pixels, width by height. 640 x 480 resolution means that the screen is 640 pixels wide by 480 tall, an aspect ratio of 4:3. With the exception of one resolution combination (1280 x 1024 uses a ratio of 5:4), all aspect ratios are the same.

Colour Monitor

A display monitor capable of displaying many colors. In contrast, a monochrome monitor can display only two colors -- one for the background and one for the foreground. Color monitors implement the RGB color model by using three different phosphors that appear **r**ed, **g**reen, and **b**lue when activated. By placing the phosphors directly next to each other, and activating them with different intensities, color monitors can create an unlimited number of colors. In practice, however, the real number of colors that any monitor can display is controlled by the video adapter.

Refresh Rate

The **refresh rate** (most commonly the "vertical refresh rate", "vertical scan rate" for cathode ray tubes) is the number of times in a second that a display hardware updates its buffer. This is distinct from the measure of frame rate in that the refresh rate includes the repeated drawing of identical frames, while frame rate measures how often a video source can feed an entire frame of new data to a display.

1.6.2. Monitor Size *

>>>>>>>>>>>>>>>>Incomplete?????????????????????????????????

1.6.3. CRT and LCD monitors

A computer monitor, technically termed as a visual display unit, can be plainly described as an electronic device that transmits information from the computer onto a screen, thereby acting as an interface and connecting the viewer with the computer. At present, computer monitors are available in a variety of shapes, designs, and colors. However, based on the technology used to make computer monitors, they can be broadly categorized into three types.

1. CRT (Cathode Ray Tube)
2. LCD (Liquid Crystal Display)
3. LED (Light-Emitting Diodes)

CRT (Cathode Ray Tube) Monitors

These monitors employ the CRT technology used most commonly in the manufacturing of television screens. In this, a stream of intense high energy electrons is used to form images on a fluorescent screen. A cathode ray tube is a basically a vacuum tube containing an electron gun at one end and a fluorescent screen at another end. From this electron gun, a process called thermionic emission generates a strong beam of electrons. These electrons travel through a narrow path within the tube with high speed using various electro-magnetic devices and finally strike the phosphor points present on the fluorescent screen, thus creating an image. There are several advantages of using CRT monitors:

- These monitors are highly reliable and efficient, and are capable of generating a resolution of up to 2048 x 1536 pixels, thereby providing a clear picture quality. Also, CRT monitors that are now available are capable of producing thousands of different colors.
- Secondly, CRT monitors are affordable and cost effective.
- Unlike conventional CRT monitors, modern technological advancements have resulted in the development of flat screen CRT monitors that reduce the glare and are good for the eyes.

However, the only concern with buying CRT monitors is that they are heavy and can occupy a great deal of work space. Also, these devices get heated up very easily.

LCD (Liquid Crystal Display) Monitors

Liquid crystal display, also known as liquid crystal diode, is one of the most advanced technologies available at present. Typically, an LCD monitor consists of a layer of color or monochrome pixels arranged schematically between a couple of transparent electrodes and two polarizing filters. Optical effect is achieved by polarizing the light in varied amounts and making it pass through the liquid crystal layer. At present, there are two types of LCD technology available. These include the active matrix or TFT and a passive matrix technology. Among these, TFT technology is more secure and reliable, and generates better picture quality. On the other hand, passive matrix has a slow response time and is slowly becoming outdated.

In recent times, LCD monitors have become increasing popular with consumers. Some major advantages of using an LCD monitor include:

- These monitors are compact, lightweight, and do not consume much desk space.
- Secondly, these monitors do not consume much electricity and can even be operated by using batteries.
- Also, the images transmitted by these monitors do not get geometrically distorted and have little flicker.

However, LCD monitors do have certain disadvantages. Most importantly, these monitors are very expensive. Secondly, image quality is not constant when viewed from different angles. Also, an LCD monitor's resolution is always constant. Any alterations can result in a reduced performance.

LED (Light-Emitting Diodes) Monitors

LED monitors are the latest types of monitors in the market today. Like LCD, it is again a flat panel display making use of light-emitting diodes for back-lightning instead of Cold Cathode Fluorescent (CCFL) back-lightning used in LCDs. Primarily, the display is of LCD only but the back-lightning is done by LEDs.

LED monitors are said to use much lesser power than CRT and LCD. Thus, they are also considered environmental friendly. Other core advantages of LED monitors are:

1. They produce images with higher contrast
2. They have less negative environmental impact when disposed
3. Lifespan and durability of LED monitors is more than CRT or LCD monitors
4. Because of the technology, the monitor panels can be made very thin
5. Do not produce much heat while running

LED monitors are little expensive than the former types. There are multiple ways by which LED back-lightning is done.

- White-edge LEDs are fixed around the rim of the monitor. It used a special diffusion panel to spread light evenly behind the screen.
- An array of LEDs are placed behind the screen. Their brightness is not controlled individually.
- Again an array of LEDs are placed behind the screen, but the brightness of each individual LED is controlled separately.

1.7. Keyboards and Mouse

Keyboards

In computing, a **computer keyboard** is a typewriter-style device which uses an arrangement of buttons or keys to act as a mechanical lever or electronic switch. Following the decline of punch cards and paper tape, interaction via teleprinter-style keyboards became the main input device for computers.

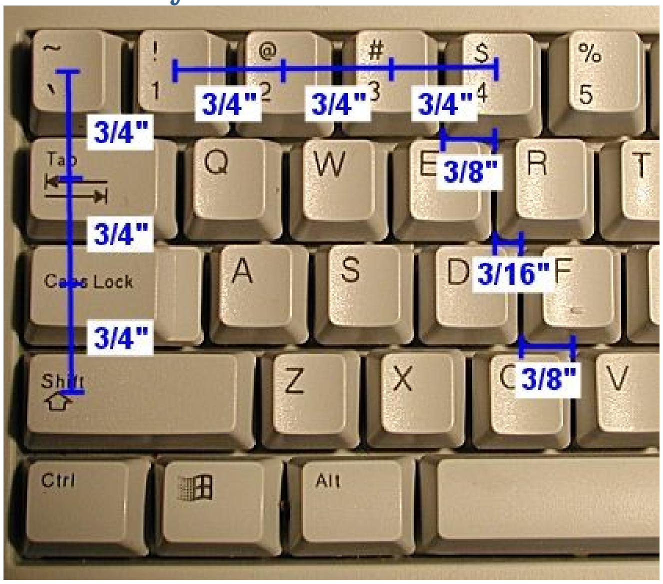
A keyboard typically has characters engraved or printed on the keys (buttons) and each press of a key typically corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence. While most keyboard keys produce letters, numbers or signs (characters), other keys or simultaneous key presses can produce actions or execute computer commands.

Mouse

A **computer mouse** is a pointing device (hand control) that detects two-dimensional motion relative to a surface. This motion is typically translated into the motion of a pointer on a display, which allows a smooth control of the graphical user interface.

Physically, a mouse consists of an object held in one's hand, with one or more buttons. Mice often also feature other elements, such as touch surfaces and "wheels", which enable additional control and dimensional input.

Keyboard construction



Keycaps

Keycaps are the actual physical keys that you strike with your fingers when typing. The term "keycap" arises from the fact that these pieces "cap" the actual keyswitches that move during a keystroke, and tell the keyboard circuitry which keys were hit. Keycaps are also sometimes called "key tops" or even just "keys" (I avoid the latter term to reduce ambiguity.)

Keycap Size, Spacing and Alignment

Almost all regular PC keyboards use keycaps of the approximate same size. In this context, I am referring to "size" as the width and depth of each keycap (the *height* of the keycaps we'll examine when we talk about travel.) The size of a regular keycap is approximately 0.5 inches square on the top of the keycap. The keycap then tapers down to a larger size at its base; a little under 0.75 inches square (about 11/16ths of an inch).

Spacing of keycaps is also very standardized, at about 0.75 inches from the center of one key to the center of its neighbor on either side. Each row of keys in the main alphanumeric area of the keyboard is also separated by about 0.75 inches of space in a typical keyboard.

Keycap shape and texturing

- **Cylindrical Curvature:** The surface of the key is concave but only in one dimension, curving around the "north" to "south" axis (viewed from the top of the keyboard). This means the top and bottom edges of each keycap have a curve but the left and right edges are straight. The top of the key looks like a cylinder of the correct size would fit into it.

- **Spherical Curvature:** The surface of the key is concave in both dimensions, so all four edges are curved. The top of the key would best fit a sphere of the appropriate size.

Keycap Travel

- A very important ergonomic and comfort design factor for keyboards is *keycap travel*. This refers to the distance the keycaps move when the keys are pressed. A keyboard whose keys move down a great deal (relatively speaking) is said to have a "long" travel, while one whose keys move relatively little has a "short" travel. Travel is determined in part by overall keyboard design, but is also a function of the keyswitch technology used.

-

- **Keycap Attachment and Special Keycaps**

- On most keyboards, the regular keys are attached to the keyswitches simply using friction: you press the keycap down on the keyswitch, and a plastic piece in the top of the keyswitch (often shaped like a plus sign; "+") fits into a matching slot in the underside of the keycap. To remove the keycap, you just hook something under the bottom of the keycap and apply gentle but firm pressure until it pops off. This is fairly straight-forward, and is of course the whole point of keycaps, that they should be easy to remove and replace. (You do need to be careful not to apply excessive force, or you could break the keyswitch or the keycap.)

- ## Keyswitches

- The main job of the keyboard is of course to translate motion of the fingers into text-based commands sent to the PC. In order to perform this task, the keyboard must have a way of detecting when keys are pressed. This detection is done through the use of small devices called *keyswitches*. One is used for each key on the keyboard. When you press down on the keycap of a key, it pushes the keyswitch down, causing the keyboard to register the keypress. A switch, of course, is something that can be turned on or off; they come in all different shapes and sizes, and they are used everywhere in our lives. Despite their differences they all perform the same basic way: changing a flow of electricity in response to a stimulus

Keyboard key groupings>>>>>>>>>>>>>>>>>>Incomplete>>>>>>>>>>>

1.7.2.1. Alphanumeric Key Layouts

Dvorak(-Dealey) Alphanumeric Layout

As mentioned in [the section on the QWERTY keyboard layout](), that universal design is really rather inefficient; the keys are located in rather strange places and as a result, a lot of finger motions are needed to complete most typing tasks. While QWERTY still dominates PC keyboard alphanumeric layouts, there is an optional layout that some people prefer. It's called the *Dvorak-Dealey* keyboard layout, with the name often simplified to just the *Dvorak* keyboard layout.

Standard Keyboard layout