HARDWARE AND OPERATING SYSTEMS.

Computers are devices which store, manage and use pieces of information.

Nowadays computers are designed according to the von Neumann's structure which consists mainly of a process unit to manage the data, a memory device to store data and programs, devices to get input and output information, and buses to link each other.

Computer hardware is the -collection of **physical** parts or devices that make up a computer. All of which are components you can “touch” (e.g. keyboard, mouse, monitor, hard disc, etc).

Software is the -collection of programs that give a logical structure to the computer, and allows it to carry on different tasks. (you cannot “touch” the software since it has not physical existence. It is just a “code” with several instructions and commands to the computer).

Main Computer Components

CPU stands for Central Process Unit and, it is actually the true “computer brain”. It manages the information and controls all the activity developed by the system.

It is made up of:

Control Unit: Controls the communications, and the different tasks according to program instructions.

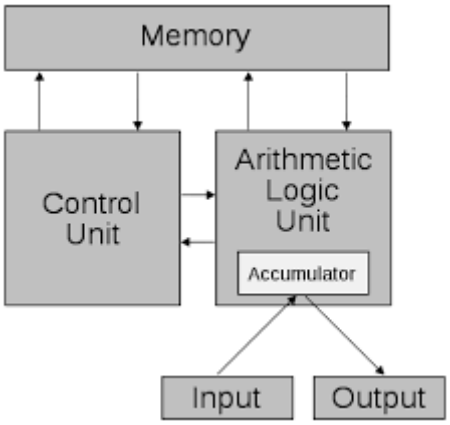
ALU (Arithmetic – Logic Unit): It makes basic arithmetic operations (sum, subtraction, multiplication, division) and logical operations.

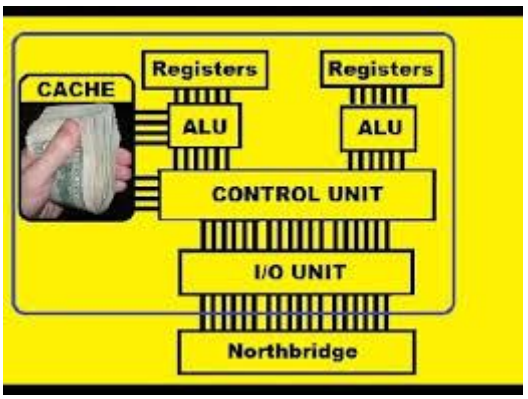
Registers: They are memory banks built inside the CPU. Because of their inner location and the technology they are designed, access to this memory banks is very fast.

Accumulator: This is a special register the computer uses to perform mathematical operations.

Program Counter: This is a special register the computer uses to index the next program instruction to be executed.

Stack pointer: This is a special register the computer uses to index the end of a buffer.





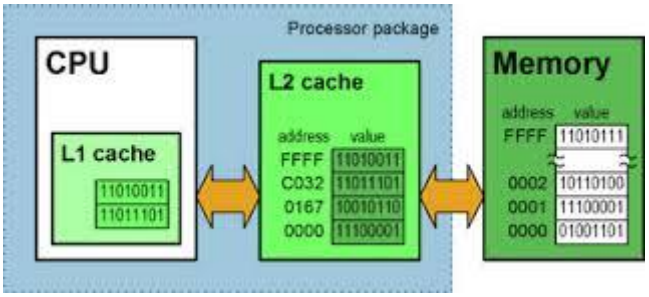
Main Memory: This is the computer working memory bank. The computer uses this memory as a notebook. Every datum the computer is manipulating at certain time is located on this memory. (Data and program commands all together).

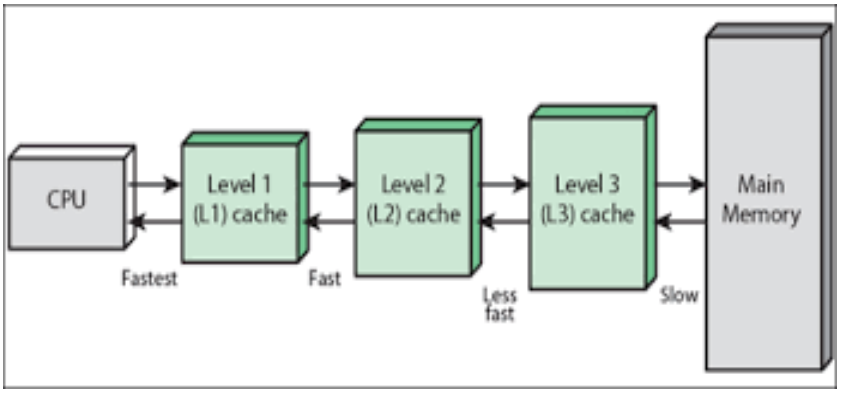
It is the only one directly accessible to the CPU. The CPU continuously reads instructions stored there and executes them as required. Any data actively operated on is also stored there in uniform manner.

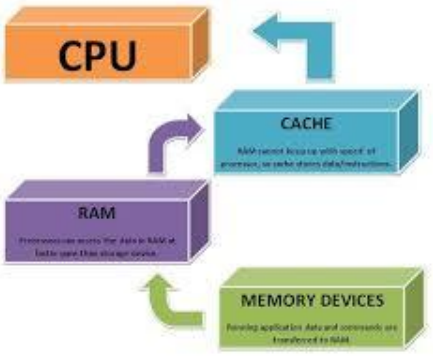
It is a RAM memory then data are deleted as soon as it is not powered. Since RAM doesn't retain information without power, if we switch off the computer we'll lose our work unless we have saved it to the hard disk.

Cache Memory: Since the access to the Main Memory is not as far as the CPU process speed, there is another RAM memory located between the Main Memory and the CPU.

This cache memory works faster as it is built with a more advanced technology, (SRAM memory), and its size is smaller. (This smaller size allows us to find a data faster as there are less data to check up). Its purpose is to speed up memory access.







Buses: They are parallel electrical wires that connect all the major computer devices.

The bus capacity to transfer data depends on the number of bits it can carry in parallel, (physical parallel electrical wires) and on the switching speed.

There are two kinds of buses according to the way they send the information:

Serial buses: They send one bit at a time so that they send one bit after the previous one until they have sent the whole message.

Parallel buses: They send a set of bits at the same time. (in one clock pulse).

There are four types of buses according to their purpose:

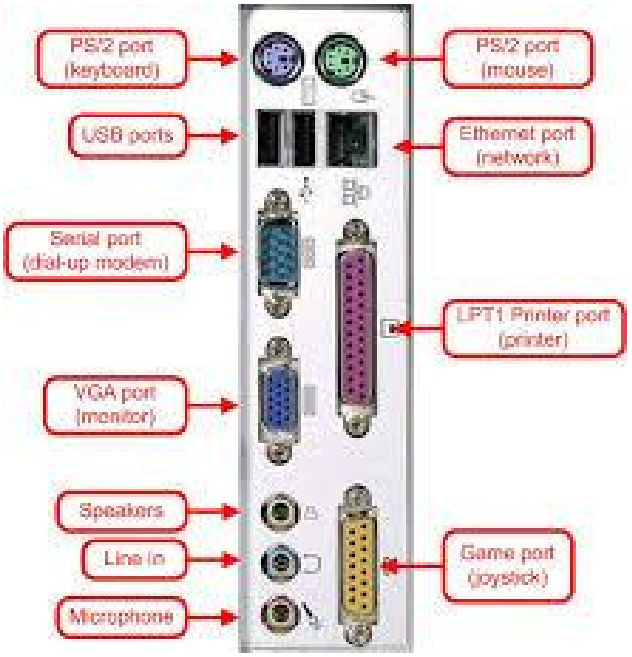
Power Bus: It supplies power to the devices.

Data Bus: It allows different data to be transferred from / to main memory banks or secondary memory devices to/from CPU and other devices (printers, …).

Address Bus: It points out to the memory position addresses where data are going to be written or read.

Control Bus: The control signals generated by CPU and other devices are kept by these buses.

Ports (hardware):They are the access gates to the buses. Physically they are slots and sockets and they've got associated a register to work with.



Ports (software):

In the internet protocol suite, a port is an endpoint of communication in an operating system, (an address). While the term is also used for hardware devices, in software it is a

logical construct that identifies a specific process or a type of network service.

A network socket is an endpoint of a connection across a computer network.

socket address is the combination of an IP address and a **port number**, much like one end of a telephone connection is the combination of a phone number and a particular extension.

Storage Devices: These devices are thought to store huge quantities of information.

We use data storage units to save data permanently since the main memory stores them temporarily and disappears when the computer is turned off.

The CPU cannot work directly in this kind of memory because it cannot index all .

For instance: CD-ROM, DVD-ROM, HARD DISK, ….

The most used device is the Hard disk, which houses the operating system and data. The traditional ones are magnetic and the most modern ones are SSD, solid state devices. While the former have disks that rotate at high speed and arms that record and read information magnetically the latter are based on semiconductors and are much faster. They have no movable parts.

Disk partitioning or **disk slicing** 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. 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.

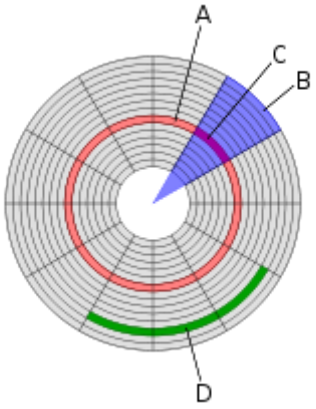
From a logical point of view the disk has a booting sector and several partitions. There should be an active partition that contains the operating system targeted by the MBR.

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.

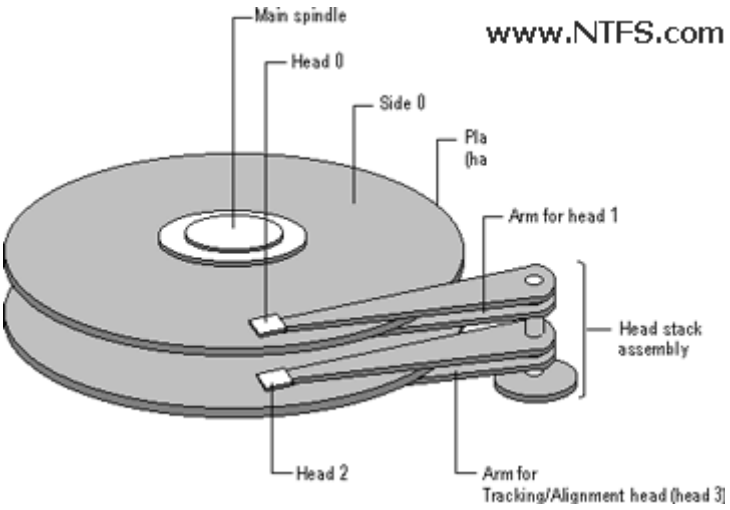
The set of tracks with the same diametre in different platters define a **cylindre**.

A sector is the smallest physical storage unit on the disk. It is almost always 512 bytes in size.

A **cluster** or **allocation unit** is a unit of disk space allocation for files and directories. To reduce the overhead of managing on-disk data structures, the filesystem does not allocate individual disk sectors by default, but contiguous groups of sectors, called clusters.



(A) Track. (B) *Geometrical* sector. (C) Track sector. (D) Cluster.



Peripherals: They are devices connected to a computer but they're not part of it. They don't form part of the core computer architecture.

They are devices that perform different tasks and allow the communication between human beings and computers.

There are three types of peripherals:

Input peripherals: They are thought to send data to the computer (for instance: mouse, keyboard, microphone, digital camera, scanner, graphic tablet,...).

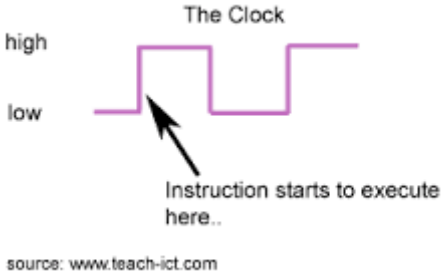
Output peripherals: They provide output from the computer to the user. (Example: printers, plotters, screens, speakers,...).

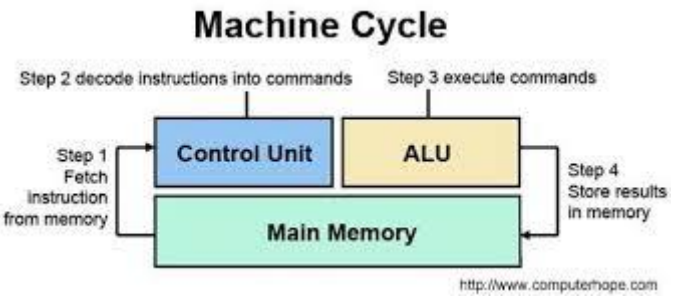
Input - Output peripherals: They allow users to get data from the computer and to introduce data to the computer. (Example: touch screens, modems,....).

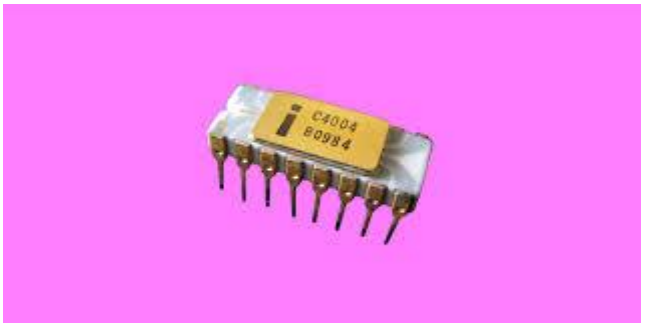
Data storage units could be thought of as this kind of peripherals.

We could consider storage devices as peripherals.

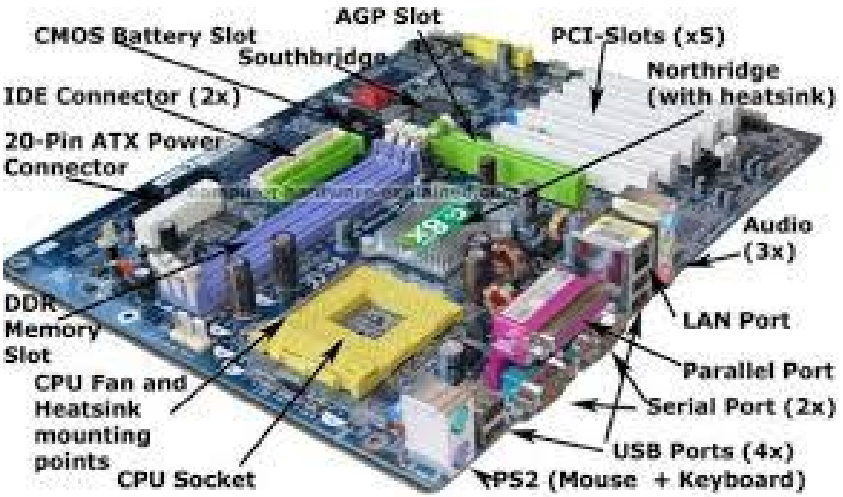
Clock: This device provides an electronic synchronizing signal to the system, so that all the components of the computer can work at the same pace.







Motherboard: It is the main computer board. All the devices are connected to this board where buses put them through to.



Chipset: It is an integrated circuit which controls the flow of data from and to the motherboard. It is assembled to this board.

Two different types: southbridge and northbridge.

The southbridge controls the input and output signals from external buses coming from the hard disk, audio devices, printers, flash memories,.... It is not directly connected to the CPU. (it works as an input/output controller hub).

It deals with low speed communications.

The northbridge is in charge of communication with the CPU and receives signals from the southbridge, the main memory, and graphic boards. (it works as a memory controller hub)

It deals with high speed communications. Both of them are controller hubs.

ROM BIOS: It is a Read Only Memory bank where data and software needed to start up the computer are stored. Every time the computer is turned on it runs a system test to

check the input and output peripherals plugged into the computer. This set of data is the BIOS (Basic Input Output System). (it's usually an EEPROM).

The BIOS,(an acronym for Basic Input/Output System and also known as the System BIOS, ROM BIOS or PC BIOS) is a type of firmware used to perform hardware initialization during the booting process on IBM PC compatible computers, and to provide runtime services for operating systems and programs] The BIOS firmware is built into personal computers (PCs), and it is the first software they run when powered on.

The fundamental purposes of the BIOS in modern PCs are to initialize and test the system hardware components, and to load a boot loader or an operating system from a mass memory device. The BIOS additionally provides an abstraction layer for the hardware, i.e., a consistent way for application programs and operating systems to interact with the keyboard, display, and other input/output (I/O) devices.

Solid State Memory Devices:

They are memory devices that have no mobile parts. They're based on semiconductors mainly silicon.

There are two kinds of solid state memories:

RAM (Random Access Memory): This memory can be used to write and read data.

When there is not power supplied the data disappear therefore when the computer is shut down they are erased.

There are two types of RAM memories:

DRAM: Dynamic RAM. From time to time we have to rewrite data to prevent them from disappearing.

SRAM: Static RAM. We don`t need to rewrite data at all. This kind of memory is faster than DRAM memory but its capacity is smaller.

The only difference is the access speed and their price.

ROM (Read Only Memory): We can only read data from this memory. We cannot write data in.

The information we read from this memory was written by the manufacturer in the beginning. Once it is given some data it is not possible to change them.

There are several types of ROM memories:

PROM: Programmable Read Only Memory: In the first place, we can write data in this memory but we can only do it once.

EPROM: Erasable PROM. We can write data in this memory and erase it all together. (It is not possible to write only one datum or to delete only one datum. We have to change the whole memory and it is too slow).

EEPROM: Electrically Erasable PROM.

Flash memories: They are the most modern ones. These memories allow reading and writing of data and are not volatile.

They are presented as memories type "SD" used in cameras, smartphones and other electronic devices, and memories that connect to USB ports (USB flash drives).

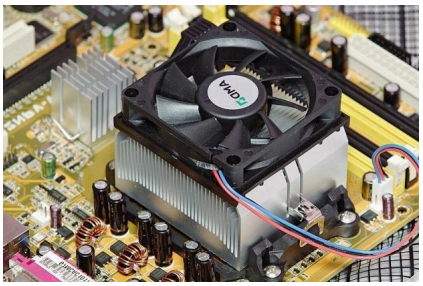
We could consider them as a special kind of RAM (the "flash memory"), although they are not volatile and are not used as the main computer memory but as "solid state drives"

How computers work by “Khan Accademy”

REFRIGERATION SYSTEMS:

All electronic systems generate heat. They must deliver this heat to the environment to prevent getting a high temperature and degrade. So that they must be refrigerated. For this reason, air fans or liquid cooling systems are used.

In addition, the microprocessor has a metal part called a heatsink on top, attached to the processor with a thermal paste that makes it easier for heat to be transferred. Above the heatsink is a fan, which cools the whole and transmits the heat to the air.



POWER SUPPLY:

It is the element in charge of converting the alternating electrical voltage of the network into several direct voltages that feed all the internal elements of the computer.

SOFTWARE CLASSIFICATION ACCORDING TO THEIR FUNCTION:

There are three types of software regarding their purpose:

Operating Systems: This software manages the computer resources and allows the communication with users and peripherals (providing a framework a Virtual Machine). The computer is given a logical structure by this software.

Applications: This kind of programs carries out different tasks to users. It makes the computer a useful machine. Examples of this software are: word processor (Word, Writer,...), spreadsheets (Excel, Calc,...), database managers (Access, …), …

Programming languages: These programs are used to make new programs, to generate software.

Operating systems have three main tasks:

- To provide a working environment (A user interface) that makes possible to communicate with the computer and to access the applications.
- To manage all the computer resources: devices, files, folders...
- To allow the communication between peripheral devices and applications.

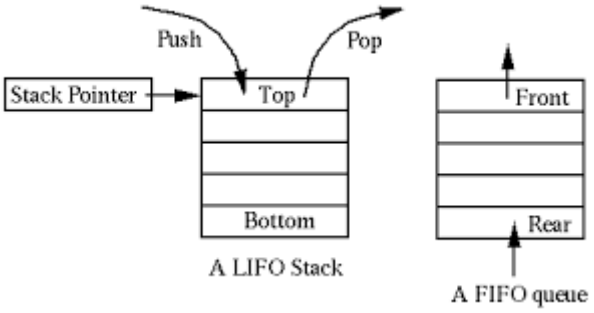
Abstract Data Structures (ADS)

There are two logical structures (two algorithms) to store data in memory temporarily:

Stacks or L.I.F.O. structure: They are data structures compounded of a pile of data in which the only way to add a new datum is through one of its ends (referred to as the top of the stack). A push operation is an operation to add up new data and a pop operation is the one to extract data from the collection.

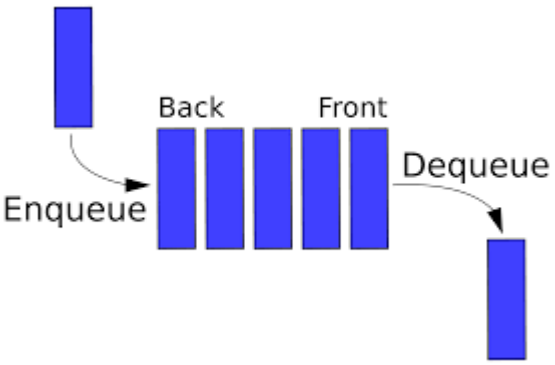
(It's a linear list of items in which all addition or deletion is restricted to one of its ends; the top)

The stack is a LIFO data structure (Last In First Out) since the first element added to the list must be the first one to be removed from the list.



Queues or F.I.F.O: structure: They are data structures made up of a collection of data in which the computer adds data through one of its ends and removes data from the other end. The first item to be removed is the first item that got into the structure. This makes it a FIFO (First In First Out) data structure. To access an item the computer must remove before the previous ones in the list.

In computer science, a buffer is a region of a physical memory storage used to temporarily store data. Buffers are used to make stacks and queues.



.

Booting a computer up (power on start up):

Booting is the process of starting a computer, specifically with regard to starting its software. The process involves a chain of stages, in which at each stage a smaller, simpler program loads and then executes the larger, more complicated program of the next stage. It is in this sense that the computer "pulls itself up by its bootstraps",

Booting is a chain of events that starts with execution of hardware-based procedures and may then hand-off to firmware and software which is loaded into main memory.

On an IBM PC compatible machine, the BIOS selects a boot device, then copies the “boot sector” (the first sector from the device which may be a MBR, VBR or any executable code), into physical memory at a certain memory address.

The conventional MBR code checks the MBR's partition table for a partition set as bootable. If an active partition is found, the MBR code loads the boot sector code from that partition, known as Volume Boot Record (VBR), and executes it.

The VBR is often operating-system specific; however, in most operating systems its main function is to load and execute the operating system kernel, which continues startup.

A Master Boot Record (MBR) is the first sector of a data storage device that has been partitioned. The MBR sector may contain code to locate the active partition and invoke its Volume Boot Record.

A Volume Boot Record (VBR) is the first sector of a data storage device that has not been partitioned, or the first sector of an individual partition on a data storage device that has

been partitioned. It may contain code to load an operating system (or other standalone program) installed on that device or within that partition.

A boot sector is a region of a hard disk, floppy disk, optical disc, or other data storage device that contains machine code to be loaded into the main memory (as you know a random access memory ,RAM) by a computer system's built-in firmware. The purpose of a boot sector is to allow the boot process of a computer to load a program (usually, but not necessarily, an operating system) stored on the same storage device. The location and size of the boot sector (perhaps corresponding to a logical disk sector) is specified by the design of the computing platform.

Summarizing:

First stage: The computer runs a code (a firmware) located at a specified memory address.

This address is in a section of non-volatile memory designed to contain instructions to start the operation of the CPU, as the first step in the process of booting the system containing the CPU. (This memory location typically contains a jump instruction that transfers execution to the location of the BIOS start-up program).

Second stage: This first program calls the B.I.O.S program.

Third stage: the BIOS “reads” the MBR(from a hard disk)/VBR (from a USB flash memory) and it is executed.

Fourth stage: the CPU loads a certain part of the operating system (its kernel) into the main memory.

Since code in the boot sector is executed automatically, boot sectors have historically been a common attack vector for computer viruses.

To combat this behavior, the System BIOS often includes an option to prevent software from writing to the first sector of any attached hard drives; it could thereby protect the Master Boot Record containing the partition table from being overwritten accidentally, but not the Volume Boot Records in the bootable partitions. Depending on the BIOS, attempts to write to the protected sector may be blocked with or without user interaction.

Some modern CPUs and microcontrollers (for example, TI OMAP) or sometimes even DSPs may have boot ROM with boot code integrated directly into their silicon, so such a processor could perform quite a sophisticated boot sequence on its own and load boot programs from various sources like NAND flash, SD or MMC card and so on. It is difficult to hardwire all the required logic for handling such devices, so an integrated boot ROM is used instead in such scenarios. Boot ROM usage enables more flexible boot sequences than hardwired logic could provide.