Microprocessor

Microprocessor

Chapter 1

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Definition

- Computer
  - A device that accepts input, processes data, stores data, and produces output, all according to a series of stored instructions.
- Hardware
  - Includes the electronic and mechanical devices that process the data; refers to the computer as well as peripheral devices.
- Software
  - A computer program that tells the computer how to perform particular tasks.
- Network
  - Two or more computers and other devices that are connected, for the purpose of sharing data and programs.
- Peripheral devices
  - Used to expand the computer's input, output and storage capabilities.

Computer Users

- **End-users** – A user who interacts with a computer system to get his/her tasks done.
- **Operators** – Operators are users who are specially trained to use particular software or carry out specific task.
- **Programmers** – These users write programs and software for a computer system.
- **Analysts** – Analyst are users who are experts in understanding, analyzing, evaluating and conceptualizing systems.
- **Developers** – Developers are advanced-users who think and create new applications for a computer system.
- **Administrators** – In multi-user computer systems many people work on the system, simultaneously.

Characteristics of Computer

- **Speed** – Many of today's computers can perform hundreds of millions of processing operations in one second.
- **Accuracy** – The computer's processing circuits rarely make errors..
- **Versatility** – Computers can handle a variety of applications and jobs and can be used in various fields.
- **Automation** – Human intervention is not much required once the instructions and data are given.
- **Storage** – A computer can store voluminous data and information.
- **Programmability** – A computer is programmable. A program is the list of instructions telling the computer what to do.
- **Cost effectiveness** – Computers do away with manual labor reducing the labor cost.

Data, Information, Program, Process

- Data
  - Refers to the symbols that represent facts, objects, or ideas.
- Information
  - The results of the computer storing data as bits and bytes; the words, numbers, sounds, and graphics.
- Program
  - Set of instructions is called program.
- Process
  - A program is called process when it is in the execution state.

Different Modules of Computer

- Input
  - Whatever is put into a computer system.
- Output
  - Consists of the processing results produced by a computer.
- Processing
  - Manipulation of the data in many ways.
- Memory
  - Area of the computer that temporarily holds data waiting to be processed, stored, or output.
- Storage
  - Area of the computer that holds data on a permanent basis when it is not immediately needed for processing.

Processor Generations

Processor	Address Bus	Data Bus	Clock Speed
4004	10	4	108KHz
8008	14	8	200KHz
8080	16	8	2MHz
8085	16	8	5MHz
8086	20	16	5MHz
8088	20	8	5MHz
80286	24	16	8MHz
80386	32	32	16MHz
80486	32	32	25MHz
Pentium	32	32/64	60MHz
Pentium Pro	36	32/64	150MHz
Pentium II	36	64	233MHz
Pentium III	36	64	650MHz
Pentium 4	36	64	1.4GHz

Processor Generations

The first microprocessor was the 4-bit Intel 4004 released in 1971, with the Intel 8008 and other more capable microprocessors becoming available over the next several years. However, both processors required external chips to implement a working system, raising total system cost, and making it impossible to economically computerize appliances.

The Smithsonian Institution says TI engineers Gary Boone and Michael Cochran succeeded in creating the first microcontroller in 1971. The result of their work was the TMS 1000, which went commercial in 1974. It combined read-only memory, read/write memory, processor and clock on one chip and was targeted at embedded systems.

Processor Generations

Partly in response to the existence of the single-chip TMS 1000, Intel developed a computer system on a chip optimized for control applications, the Intel 8048, with commercial parts first shipping in 1977. It combined RAM and ROM on the same chip.

This chip would find its way into over one billion PC keyboards, and other numerous applications. At that time Intel's President, Luke J. Valenter, stated that the microcontroller was one of the most successful in the company's history, and expanded the division's budget over 25%.

Processor Generations

Most microcontrollers at this time had two variants. One had an erasable EPROM program memory, with a transparent quartz window in the lid of the package to allow it to be erased by exposure to ultraviolet light. The other was a PROM variant which was only programmable once; sometimes this was signified with the designation OTP, standing for "one-time programmable".

The PROM was actually exactly the same type of memory as the EPROM, but because there was no way to expose it to ultraviolet light, it could not be erased. The erasable versions required ceramic packages with quartz windows, making them significantly more expensive than the OTP versions, which could be made in lower-cost opaque plastic packages. For the erasable variants, quartz was required, instead of less expensive glass, for its transparency to ultraviolet—glass is largely opaque to UV—but the main cost differentiator was the ceramic package itself.

Processor Generations

In 1993, the introduction of EEPROM memory allowed microcontrollers (beginning with the Microchip PIC16x84) to be electrically erased quickly without an expensive package as required for EPROM, allowing both rapid prototyping, and In System Programming. (EEPROM technology had been available prior to this time, but the earlier EEPROM was more expensive and less durable, making it unsuitable for low-cost mass-produced microcontrollers.)

The same year, Atmel introduced the first microcontroller using Flash memory, a special type of EEPROM. Other companies rapidly followed suit, with both memory types.

Processor Generations

Cost has plummeted over time, with the cheapest 8-bit microcontrollers being available for under 0.25 USD in quantity (thousands) in 2009, and some 32-bit microcontrollers around 1 USD for similar quantities. The NXP-LPC810 is a 32 bit ARM CORTEX M0+ in an 8 pin DIP package and sells in single quantity for £0.66 or $1.00 in 2013.

Nowadays microcontrollers are cheap and readily available for hobbyists, with large online communities around certain processors.
In the future, MRAM could potentially be used in microcontrollers as it has infinite endurance and its incremental semiconductor wafer process cost is relatively low.

Microcontroller

A **microcontroller** (sometimes abbreviated **µC**, **uC** or **MCU**) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.

Word and Nibble

Word – The word or word length is defined as the number of bits the microprocessor recognizes and processes at a time

Nibble - In computing, a **nibble** (often **nybble** or even **nyble** to match the vowels of **byte**) is a four-bit aggregation, or half an octet. As a nibble contains 4 bits, there are sixteen (2^4) possible values, so a nibble corresponds to a single hexadecimal digit (thus, it is often referred to as a "hex digit" or "hexit").

A full byte (octet) is represented by two hexadecimal digits; therefore, it is common to display a byte of information as two nibbles. The nibble is often called a "semioctet" or a "quartet" in a networking or telecommunication context.

Instruction Set, Bandwidth, Clock Speed

Instruction set: The set of instructions that the microprocessor can execute.

bandwidth : The number of bits processed in a single instruction.

clock speed : Given in megahertz (MHz), the clock speed determines how many instructions per second the processor can execute.

Note: the higher the value, the more powerful the CPU. For example, a 32-bit microprocessor that runs at 50MHz is more powerful than a 16-bit microprocessor that runs at 25MHz.

In addition to bandwidth and clock speed, microprocessors are classified as being either RISC (reduced instruction set computer) or CISC (complex instruction set computer).

Translation

Assembler: A computer will not understand any program written in a language, other than its machine language. The programs written in other languages must be translated into the machine language. Such translation is performed with the help of software. A program which translates an assembly language program into a machine language program is called an assembler. If an assembler which runs on a computer and produces the machine codes for the same computer then it is called **Self assembler or Resident assembler.** If an assembler that runs on a computer and produces the machine codes for other computer then it is called **Cross Assembler.**

Assemblers are further divided into two types: **One Pass Assembler and Two Pass Assembler.** One pass assembler is the assembler which assigns the memory addresses to the variables and translates the source code into machine code in the first pass simultaneously. A Two Pass Assembler is the assembler which reads the source code twice. In the first pass, it reads all the variables and assigns them memory addresses. In the second pass, it reads the source code and translates the code into object code.

Translation

Compiler: It is a program which translates a high level language program into a machine language program. A compiler is more intelligent than an assembler. It checks all kinds of limits, ranges, errors etc. But its program run time is more and occupies a larger part of the memory. It has slow speed. Because a compiler goes through the entire program and then translates the entire program into machine codes.

If a compiler runs on a computer and produces the machine codes for the same computer then it is known as a **Self compiler or Resident compiler.** On the other hand, if a compiler runs on a computer and produces the machine codes for other computer then it is known as a **Cross compiler.**

Translation

Interpreter: An interpreter is a program which translates statements of a program into machine code. It translates only one statement of the program at a time. It reads only one statement of program, translates it and executes it. Then it reads the next statement of the program again translates it and executes it. In this way it proceeds further till all the statements are translated and executed. On the other hand, a compiler goes through the entire program and then translates the entire program into machine codes**. A compiler is 5 to 25 times faster than an interpreter.**

By the compiler, the machine codes are saved permanently for future reference. On the other hand, the machine codes produced by interpreter are not saved. An interpreter is a small program as compared to compiler. It occupies less memory space, so it can be used in a smaller system which has limited memory space.

Translation

Linker: In high level languages, some built in header files or libraries are stored. These libraries are predefined and these contain basic functions which are essential for executing the program. These functions are linked to the libraries by a program called Linker. If linker does not find a library of a function then it informs to compiler and then compiler generates an error. The compiler automatically invokes the linker as the last step in compiling a program.

Not built in libraries, it also links the user defined functions to the user defined libraries. Usually a longer program is divided into smaller subprograms called modules. And these modules must be combined to execute the program. The process of combining the modules is done by the linker.

Translation

Loader: Loader is a program that loads machine codes of a program into the system memory. In Computing, a **loader** is the part of an Operating System that is responsible for loading programs. It is one of the essential stages in the process of starting a program. Because it places programs into memory and prepares them for execution.

Loading a program involves reading the contents of executable file into memory. Once loading is complete, the operating system starts the program by passing control to the loaded program code. All operating systems that support program loading have loaders. In many operating systems the loader is permanently resident in memory.

Hardware and Operating System

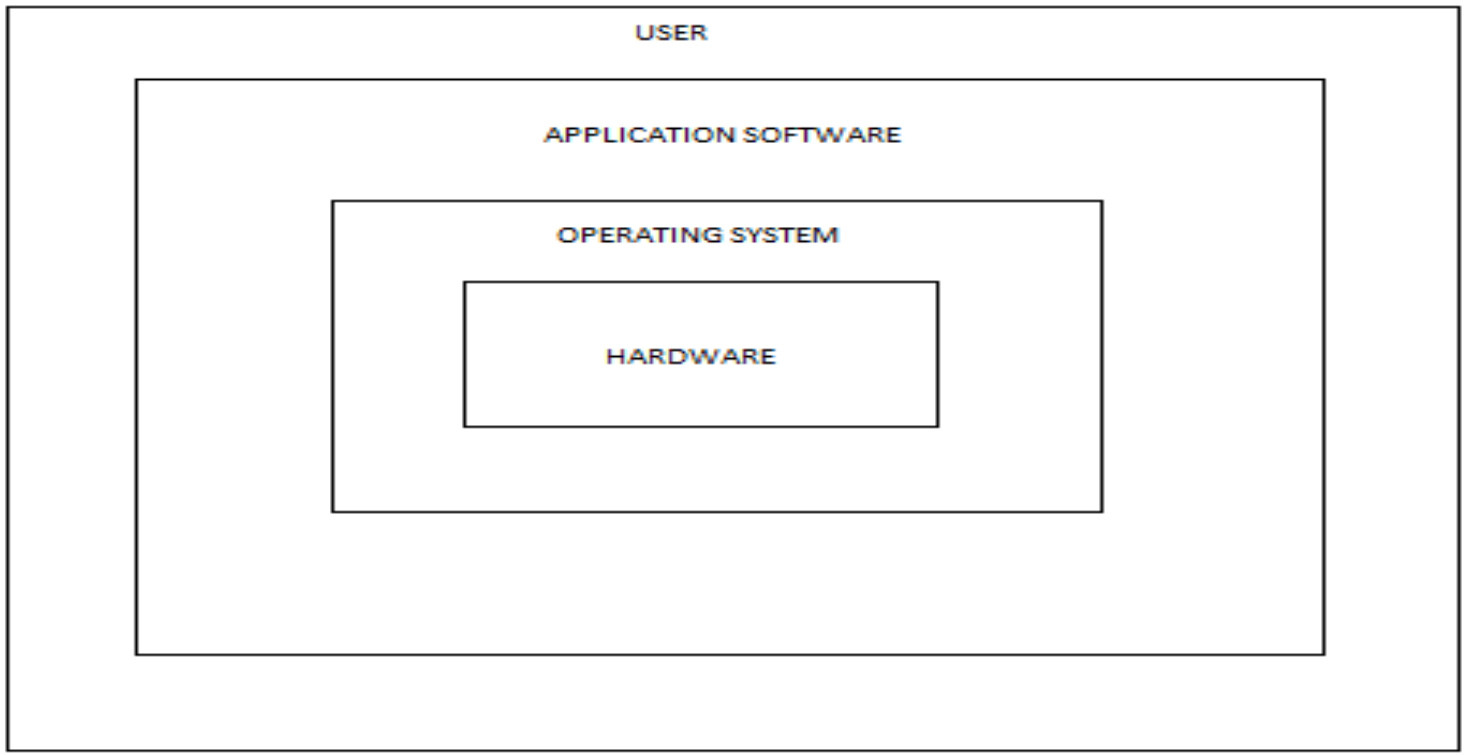


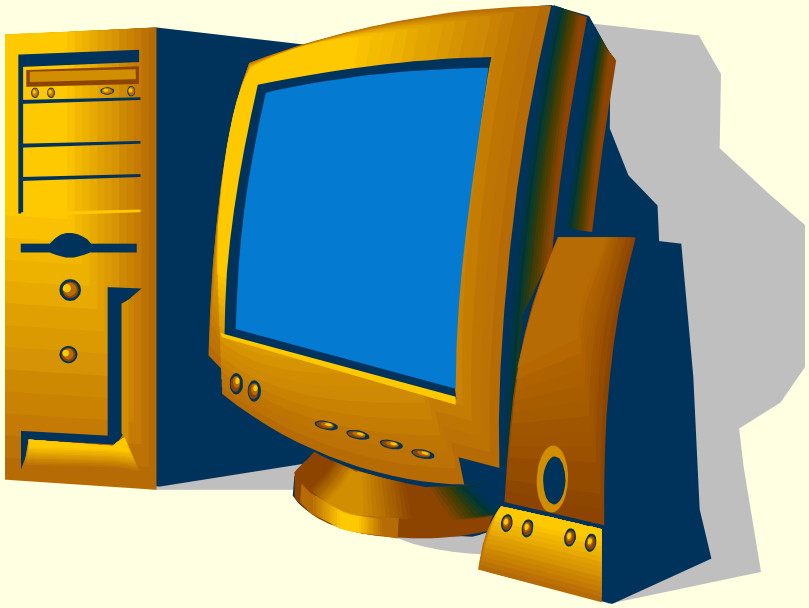
FIGURE: OPERATING SYSTEM AND ITS FUNCTIONAL RELATIONSHIP WITH VARIOUS HARDWARE COMPONENTS

Types of Computers

Microcomputer

- A personal computer; designed to meet the computer needs of an individual.
- Provides access to a wide variety of computing applications, such as word processing, photo editing, e-mail, and internet.

Desktop Microcomputer



- A microcomputer that fits on a desk.
- The CPU can be housed in either a vertical or a horizontal case.
- Has separate components (keyboard, mouse, etc.) that are each plugged into the computer.

Laptop Computer

- A portable, compact computer that can run on an electrical wall outlet or a battery unit.
- All components (keyboard, mouse, etc.) are in one compact unit.
- Usually more expensive than a comparable desktop.
- Sometimes called a Notebook.

Workstation

- Powerful desktop computer designed for specialized tasks.
- Can tackle tasks that require a lot of processing speed.
- Can also be an ordinary personal computer attached to a LAN (local area network).

Supercomputer

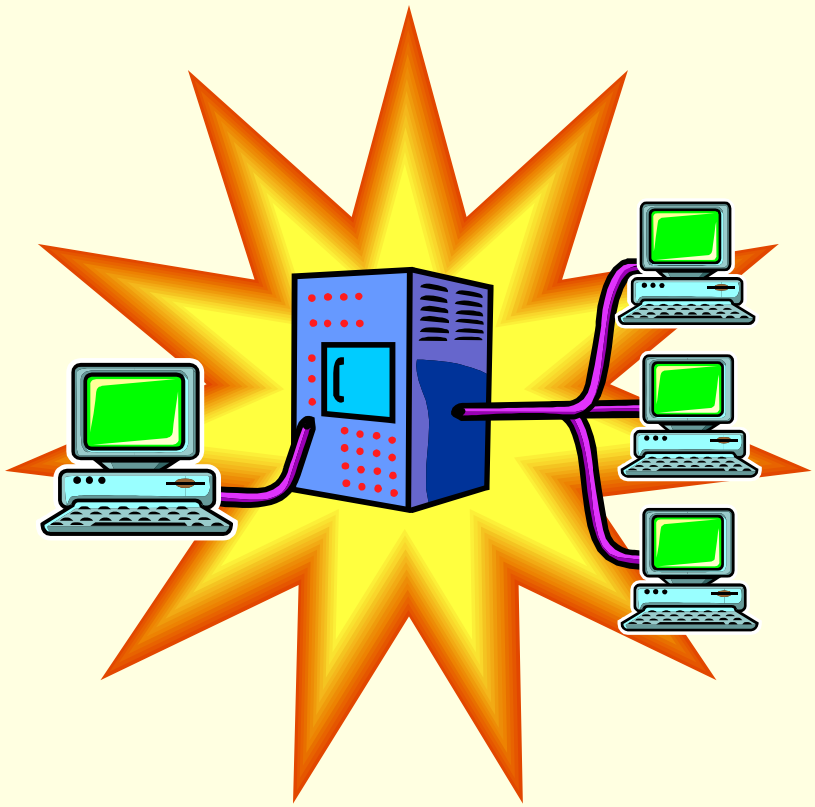
- A computer that was the fastest in the world at the time it was constructed.
- Can tackle tasks that would not be practical for other computers.
  - Typical uses
    - Breaking codes
    - Modeling weather systems

Mainframe

- Large expensive computer capable of simultaneously processing data for hundreds or thousands of users.
- Used to store, manage, and process large amounts of data that need to be reliable, secure, and centralized.
- Usually housed in a closet sized cabinet.

Server

- Purpose is to “serve.”
- A computer that has the purpose of supplying its users with data; usually through the use of a LAN (local area network).



Handheld

- Also called a PDA (Personal Digital Assistant).
- A computer that fits into a pocket, runs on batteries, and is used while holding the unit in your hand.
- Typically used as an appointment book, address book, calculator, and notepad.
- Can be synchronized with a personal microcomputer as a backup.

ASSIGNMENT 1

- Differentiate between Microprocessor and Microcontroller.
- Differentiate between 16-bit word and 32-bit word.
- Distinguish between Cross Compiler and Interpreter.
- Write the functions of Assembler, Loader and Linker.
- Describe the advantages with example of Multi-User-Multi-Tasking operating system rather than Single-User-Multi-Tasking operating system

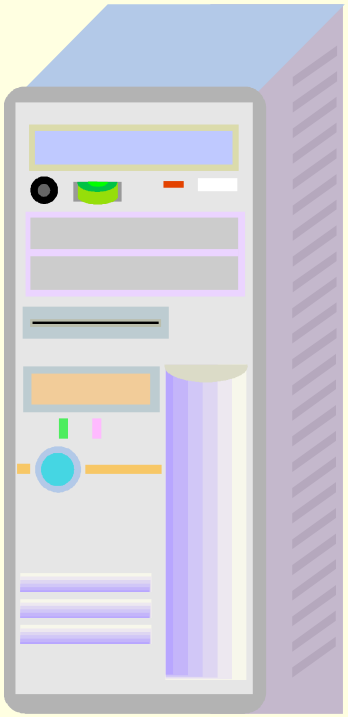
END

END OF CHAPTER 1

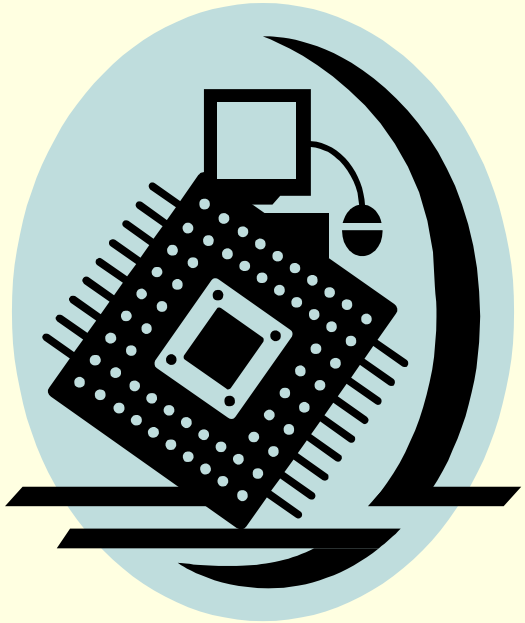
Computer Hardware

System unit

- Case that holds the power supply, storage devices, and the circuit boards (including the motherboard).



CPU (Central Processing Unit)



- Where the processing in a computer takes place, often called the brain of the computer.

Input Devices

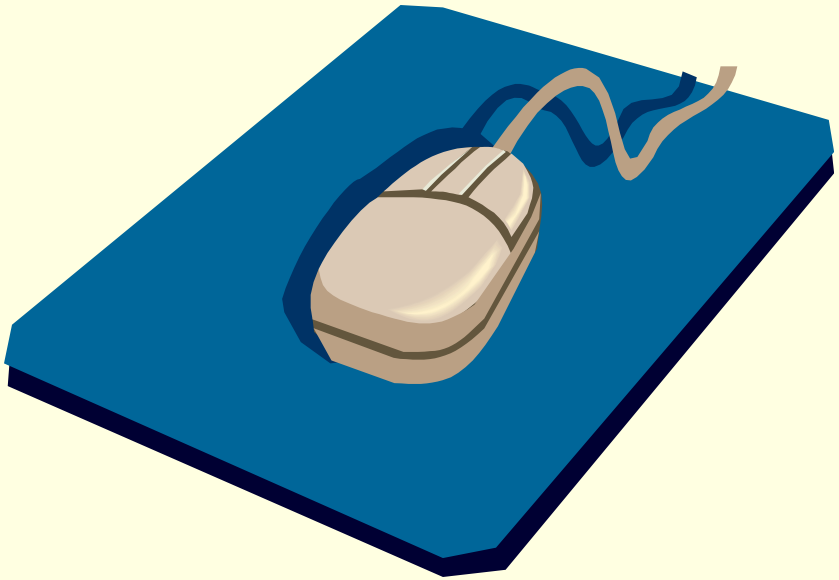
- Units that gather information and transform that information it into a series of electronic signals for the computer.

Keyboard

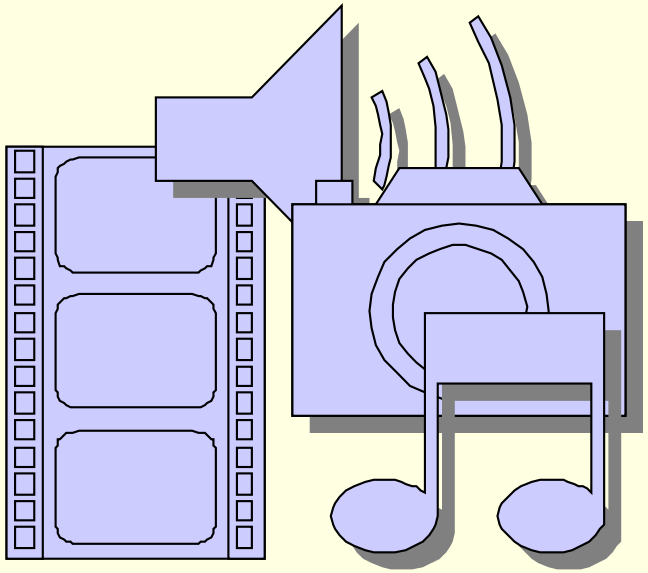
- An arrangement of letters, numbers, and special function keys that act as the primary input device to the computer.

Mouse

- An input device that allows the user to manipulate objects on the screen by moving the device along the surface of a desk.



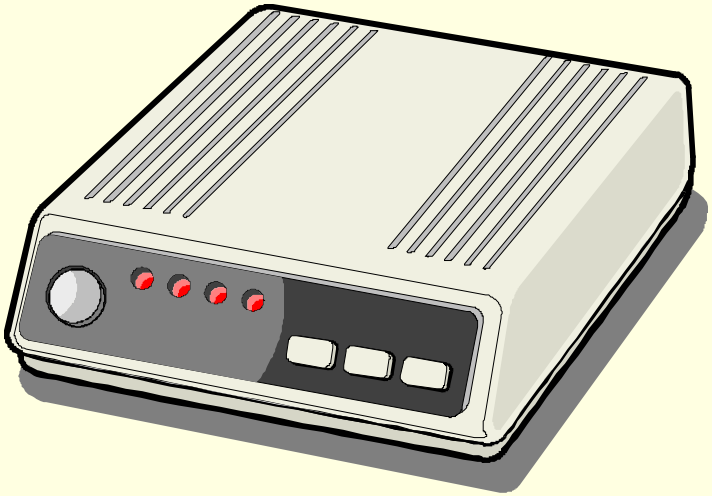
Sound Card



- A circuit board that gives the computer the ability to accept audio input, play sound files, and produce audio output through speakers or headphones.

Modem

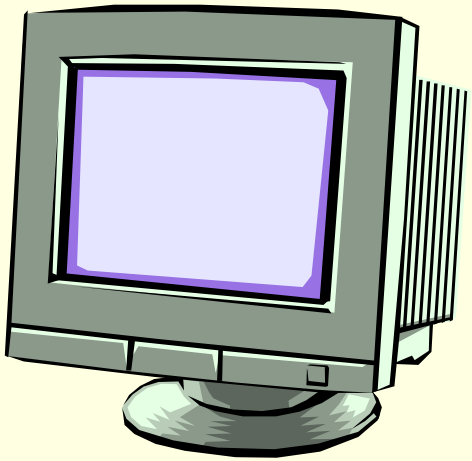
- A device that sends and receives data to and from computers over telephone lines.



Output Devices

- Devices that display, print, or transmit the results of processing from the computer's memory.

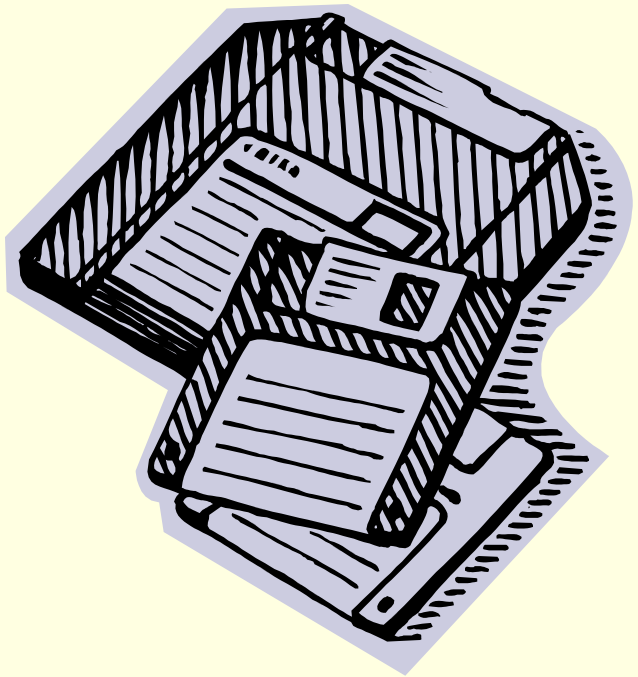
Monitor



- Display device that forms an image by converting electrical signals from the computer into points of colored light on the screen.
  - Resolution
    - The density of the grid used to display or print text and graphics; the greater the horizontal and vertical density, the higher the resolution.
  - Pixels
    - The smallest unit in a graphic image; computer display devices use a matrix of pixels to display text and graphics.

Storage Devices

- Used to keep data when the power to the computer is turned off.
- Different forms
  - Hard disk
  - Floppy or zip disks
  - CD-Writer



Printer

- Output device that produces text or graphical images on paper.

Speakers

- Output devices that receive signals from the computer’s sound card to play music, narration, or sound effects.