

Chapter 14

Computer Threats

Contents:

- 1 Introduction(Viruses,Bombs,Worms)
- 2 Categories of Viruses
- 3 Types of Viruses
- 4 Characteristics of Viruses
- 5 Computer Security
 - i. Antivirus Software
 - ii. Password, Firewalls

1 Introduction(Viruses,Bombs,Worms)

A virus is a computer program that executes when an infected program is executed.

A virus reproduces its own code by attaching itself to other executable files in such a way that the virus code is executed when the infected executable file is executed.

It attaches itself to some form of host such as legitimate, executable program. Virus lives within the program, which is said to be 'infected'. Execution of the host program implies execution of the virus. It may or may not damage the infected program.

A virus is able to replicate and it creates (possibly modified) copies of itself. It needs to have some form of distribution such as via disks or a computer network.

- Examples: W95.CIH (Chernobyl), Sampo and Hare

1.1 History of Viruses:

There are several stories of the first computer virus. The Pakistani Brain Virus (1986): is the first widely spread IBM Compatible virus. This is commonly mistaken for the first virus. The Apple Virus 1 (1981): It's a Boot sector infecting virus; it was possibly created for pirated games. The Animal (1975) (Univac): "Guess an animal" game is copied to other users' home directories when run.

2. Classifying Viruses: categories

2.1 The Computer Viruses are generally classified as follows:

- Boot Sector
- TSR (Terminate and stay resident)
- Multipartite

- Macro
- Companion
- Polymorphic

(a) Boot Sector Viruses:

Boot sector viruses are those that infect the boot sector (or master boot record) on a computer system. They first move or overwrite the original boot code, replacing it with infected boot code. They will then move the original boot sector information to another sector on the disk, marking that sector as a bad spot on the disk so it will not be used in the future. Boot sector viruses can be very difficult to detect since the boot sector is the first thing loaded when a computer is starts. In effect, the virus takes full control of the infected computer.

About three out of every four virus infections reported are boot sector viruses. The only way that a system can become infected with a boot sector virus is to boot using an infected floppy disk. This is most commonly done when a user leaves a floppy disk in a drive and reboots the system (with the drive door closed). Good anti-virus software will look for an infected floppy disk when a user boots from the floppy drive and before the boot strap is loaded.

(b)File infecting viruses

File infecting viruses are, unsurprisingly, viruses that infect files. Sometimes these viruses are memory resident. However, they will commonly infect most, if not all of the executable files (those with the extensions .COM, .EXE, .OVL and other overlay files) on a system. Some file infecting viruses will only attack operating system files (such as COMMAND.COM), while others will attack any file that is executable.

Some of these viruses act like boot sector infectors. They replace the “program load” instructions in an executable file with their own instructions, and move the original program load instructions to a different part of the file. This usually increases the file’s size, making detection a little easier. Other file infecting viruses work by using companion files. They rename all files with .COM extensions to .EXE, then write a file with the same name and a .COM extension. This new file will usually have the “hidden” attribute, making it difficult to detect with ordinary file handling commands. By default, MS-DOS executes the .COM file before the .EXE file so that the .COM file is executed first, loading the virus.

(c) TSR (Terminate and stay resident)

A TSRS virus is a virus that stays active in memory after the application (or bootstrapping, or disk mounting) has terminated.TSR viruses can be boot sector infectors or executable infectors. The Brain virus is a TSR virus.

(d) Multipartite

A multipartite virus is a virus that can infect either boot sectors or executables. Such a virus typically has two parts, one for each type. When it infects an executable, it acts

as an executable infector. When it infects a boot sector, it works as a boot sector infector.

(e) Macro

A macro virus is a virus composed of a sequence of instructions that is interpreted rather than executed directly. Macro viruses can infect either executables (Duff's shell virus) or data files (Highland's Lotus 1-2-3 spreadsheet virus).

Eg. Duff's shell virus can execute on any system that can interpret the instructions

This is Piece of self-replicating code written in an application's macro language. A macro virus requires an auto-execute macro one which is executed in response to some event e.g opening or closing a file or starting an application , once the macro virus is running, it can copy itself to other documents delete files, etc.

(f) Polymorphic

Polymorphic viruses change their appearance with each infection. Such encrypted viruses are usually difficult to detect because they are better at hiding themselves from anti-virus software. That is the purpose of the encryption.

Polymorphic viruses take encryption a step further by altering the encryption algorithm with each new infection. Some polymorphic viruses can assume over two billion different guises. This means anti-virus software products must perform algorithmic scanning, as opposed to standard string-based scanning techniques that can find simpler Viruses

3. Types of Viruses

3.1 Viruses can be of the following types:

- Worms
- Trojan Horse
- Bombs

(a) Computer Worm:

This is a **self-replicating** computer program, similar to a computer virus. Unlike a virus, it is **self-contained** and does not need to be part of another program to propagate itself. This is often designed to exploit computers' file transmission capabilities. A worm could be stated as a program or algorithm that replicates itself over a computer network or through e-mail and sometimes performs malicious actions such as using up the computer and network resources and possibly destroying data.

Examples: Klez, Nimda, Code Red

In addition to replication, a worm may be designed to: delete files on a host system, send documents via email, and carry other executables as a payload

(b) Trojan

A Trojan Horse is a destructive program that has been disguised (or concealed in) an innocuous piece of software. Indeed, worm and virus programs may be concealed within a Trojan Horse. Trojan Horses are not viruses because they do not reproduce themselves and spread as viruses do.

A program may seem both attractive and innocent, inviting the computer user to copy (or download) the software and run it. Trojan Horses may be games or some other software that the victim will be tempted to try.

They can be programmed to self-destruct, leaving no evidence other than the damage they have caused. A Trojan Horse is particularly effective for the common banking crime known as 'salami slicing' in which small sums unlikely to be noticed are sliced off a number of legitimate accounts and moved to a secret account being operated by the thief.

(c) Logic Bomb

Writing a logic bomb program is similar to creating a Trojan horse. Both also have about the same ability to damage data, too. Logic bombs include a timing device so it will go off at a particular date and time. The Michelangelo virus is embedded in a logic bomb, for example. Other virus programs often include coding similar to that used in logic bombs, but the bombs can be very destructive on their own, even if they lack the ability of the virus to reproduce.

Logic bombs are usually timed to do maximum damage.

4. How do viruses work? (Characteristics)

Once a virus gains access to a computer, its effects can vary.

Possible attacks include:

- Replicating itself
- Interrupting system/network use
- Modifying configuration settings
- Flashing BIOS
- Format hard drive/destroy data
- Using computer/network resources
- Distribution of confidential info
- Denial of Service attacks

(a) The Typical methods of infection

- Removable media or drives
- Downloading Internet files
- E-mail attachments
- Unpatched software and services
- Poor Administrator passwords
- Poor shared passwords

5. Computer Security

Different organizations have different styles of operation. This fact extends to the ways they set up their computer networks and operating procedures. That makes it impossible for any document to set down a detailed set of procedures that can be used to cover each and every organization subject to virus attack. In any case some of the procedures that could be followed are listed below:

5.1 Virus prevention

Virus prevention can be done in any of the ways listed below:

- Patching the operating system
- Patching services
- Patching client software
- Passwords
- Antivirus software
- Firewalls

(a) Passwords

As discussed earlier when talking about Trojans, strong passwords are a vital part of keeping your systems free of infection. Antivirus software does not catch the majority of the Trojans. These Trojans are typically legitimate networking tools that were never intended to be used as a Trojan. Having strong passwords will deter most worms and scanners that attempt to crack passwords as a means of entry.

The Administrator account and those users who have Administrator privileges are at the greatest risk, but all users on the network should follow the same password policy.

(b) Virus Detection (Antivirus software)

The primary method of detection of antivirus software is to check programs and files on a system for virus signatures. However, good antivirus software uses many methods to search the system for viruses.

Antivirus Software Consideration: While choosing antivirus software the following features could be considered:

- Cost (per workstation/server)
- Frequency of updates
- Ease of update installation
- Server administration
- Certification

Some of the Antivirus software options are:

- Aladdin Knowledge
- Alwil Software
- AVG Antivirus
- Central Command
- Command Software
- Computer Associates
- Data Fellows Corp.
- Dr. Solomon's Software

- ESET Software
- Finjan Software

(c) Cleaning viruses

Cleaning viruses depends entirely on your local antivirus solution. The virus must be identified before it can be removed, so it makes sense to try your antivirus scanner first.

If your software identifies, but can't remove the virus, check the manufacturer's website for manual removal instructions.

(d) Perform Basic Computer Safety Maintenance

Use an Internet "firewall", Update your computer, Use up-to-date antivirus software

1. Use an Internet Firewall

A firewall is software or hardware that creates a protective barrier between your computer and potentially damaging content on the Internet or network. The firewall helps to guard your computer against malicious users, and also against malicious software such as computer viruses and worms. Commercial hardware and software firewalls may also be used

2. Update" Your Computer

Download service packs and updates. Especially important for Windows XP users: "SP2". Use Up-to-date Antivirus Software. McAfee and Symantec are prominent vendors. **Make certain to keep "virus definitions" up-to-date.**

Summary:

The chapter details the meaning of computer viruses and their different features. It summarizes the different preventive mechanisms for viruses.

Chapter 8

Memory Units

Contents:

I. Introduction

- Basic units of Measurement

II. RAM,ROM,PROM,EPROM

- Storage versus Memory

III.Auxiliary Storage Devices-Magnetic Tape, Hard Disk, Floppy Disk

IV.Optical Disks: CD-R Drive, CD-RW disks, DVD, Blue ray Discs

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I. Introduction

The computer system essentially comprises three important parts – input device, central processing unit (CPU) and the output device. The CPU itself is made of three components namely, the arithmetic logic unit (ALU), memory unit, and the control unit.

In addition to these, auxiliary storage/secondary storage devices are used to store data and instructions on a long-term basis.

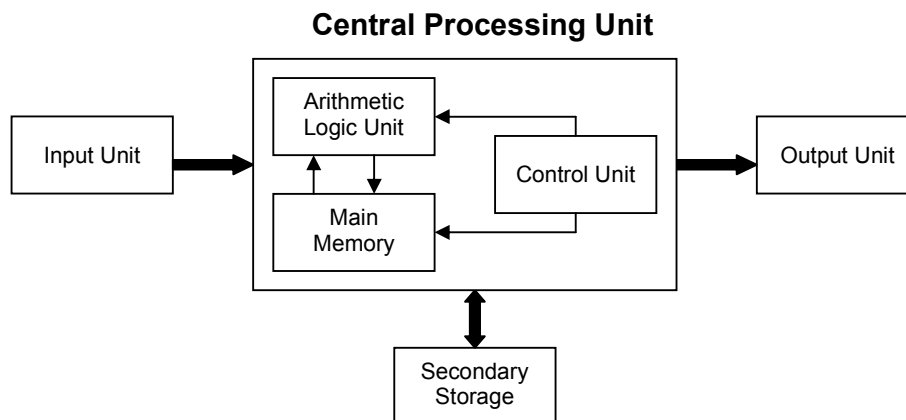


Figure 1 : Schematic Representation of a Computer

The objective of this chapter is to introduce the concept of Memory units of the computer which are shown in the above figure as main memory and secondary memory. The Memory unit is linked with other parts of the computer specifically as shown in the figure2.

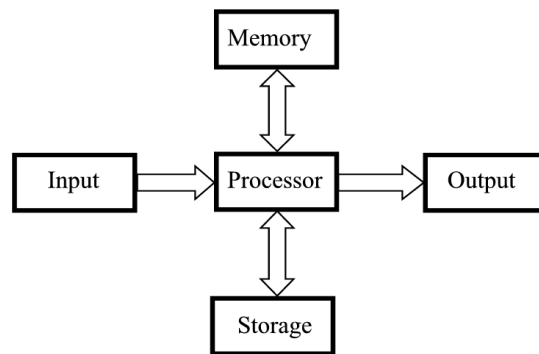


Figure 2: Linking Memory with other units

All storage devices are characterized with the following features:

- Speed
- Volatility
- Access method
- Portability
- Cost and capacity

1.1 Basic Units of Measurement

All information in the computer is handled using electrical components like the integrated circuits, semiconductors, all of which can recognize only two states – presence or absence of an electrical signal. Two symbols used to represent these two states are **0** and **1**, and are known as BITS (an abbreviation for **B**inary **D**igi**T**S). **0** represents the absence of a signal, **1** represents the presence of a signal. A BIT is, therefore, the smallest unit of data in a computer and can either store a **0** or **1**.

Since a single bit can store only one of the two values, there can possibly be only four unique combinations:

00 01 10 11

Bits are, therefore, combined together into larger units in order to hold greater range of values.

BYTES are typically a sequence of eight bits put together to create a single computer alphabetical or numerical character. More often referred to in larger multiples, bytes may appear as **Kilobytes** (1,024 bytes), **Megabytes** (1,048,576 bytes), **GigaBytes** (1,073,741,824), **TeraBytes** (approx. 1,099,511,000,000 bytes), or **PetaBytes** (approx. 1,125,899,900,000,000 bytes).

Bytes are used to quantify the amount of data digitally stored (on disks, tapes) or transmitted (over the internet), and are also used to measure the memory and document size.

II. [RAM,ROM,PROM,EPROM](#)

The Term Computer Memory is defined as one or more sets of chips that store Data/program instructions, either temporarily or permanently. It is critical processing

component in any computer. The PCs use several different types. They are :

- Main Memory / Primary Memory units
 - Two most important are
 - RAM(Random Access Memory)
 - ROM(Read-only Memory)
 - They work in different ways and perform distinct functions
 - CPU Registers
 - Cache Memory
- Secondary Memory/Auxiliary Memory

Also termed as ‘auxiliary’ or ‘backup’ storage, it is typically used as a supplement to main storage. It is much cheaper than the main storage and stores large amount of data and instructions permanently. Hardware devices like magnetic tapes and disks fall under this category.

Computer’s memory can be classified into two types – RAM and ROM.

RAM or Random Access Memory is the central storage unit in a computer system. It is the place in a computer where the operating system, application programs and the data in current use are kept temporarily so that they can be accessed by the computer’s processor. The more RAM a computer has, the more data a computer can manipulate.

Random access memory, also called the Read/Write memory, is the temporary memory of a computer. It is said to be ‘volatile’ since its contents are accessible only as long as the computer is on. The contents of RAM are cleared once the computer is turned off.

ROM or Read Only Memory is a special type of memory which can only be read and contents of which are not lost even when the computer is switched off. It typically contains manufacturer’s instructions. Among other things, ROM also stores an initial program called the ‘bootstrap loader’ whose function is to start the computer software operating, once the power is turned on.

Read-only memories can be **manufacturer-programmed** or **user-programmed**. While manufacturer-programmed ROMs have data burnt into the circuitry, user-programmed ROMs can have the user load and then store read-only programs. PROM or Programmable ROM is the name given to such ROMs.

Information once stored on the ROM or PROM chip cannot be altered. However, another type of memory called EPROM (Erasable PROM) allows a user to erase the information stored on the chip and reprogram it with new information. EEPROM (Electrically EPROM) and UVEPROM (Ultra Violet EPROM) are two types of EPROM’s.

Storage Vs. Memory

RAM is volatile memory having a limited storage capacity. Secondary/auxiliary storage is storage other than the RAM. These include devices that are peripheral and are connected and controlled by the computer to enable permanent storage of programs and data.

Magnetic medium was found to be fairly inexpensive and long lasting medium and, therefore, became the preferred choice for auxiliary storage. Floppy disks and hard disks fall under this category. The newer forms of storage devices are **optical storage**

devices like CDs, DVDs, Pen drive, Zip drive etc.

To Summaries:

The memory is specifically meaning the RAM. This keeps the information for a shorter period of time (usually volatile), is faster and more expensive.

By Storage we mean the Hard disk. Here the information is retained longer (non-volatile), It's Slower and Cheaper

III. Auxiliary Storage Devices-Magnetic Tape, Floppy Disk, Hard Disk.

The Magnetic Storage Exploits duality of magnetism and electricity. It converts electrical signals into magnetic charges, captures magnetic charge on a storage medium and then later regenerates electrical current from stored magnetic charge. Polarity of magnetic charge represents bit values zero and one.

Magnetic Disk

The Magnetic Disk is Flat, circular platter with metallic coating that is rotated beneath read/write heads. It is a Random access device; read/write head can be moved to any location on the platter.

Floppy Disk

These are small removable disks that are plastic coated with magnetic recording material. Floppy disks are typically 3.5" in size (diameter) and can hold 1.44 MB of data. This portable storage device is a rewritable media and can be reused a number of times.

Floppy disks are commonly used to move files between different computers. The main disadvantage of floppy disks is that they can be damaged easily and, therefore, are not very reliable. The following figure shows an example of the floppy disk. Figure 3 shows a picture of the floppy disk:



Figure 3: Floppy Disk

HARD DISK

Another form of auxiliary storage is a hard disk. A hard disk consists of one or more rigid metal plates coated with a metal oxide material that allows data to be magnetically recorded on the surface of the platters. The hard disk platters spin at

a high rate of speed, typically 5400 to 7200 revolutions per minute (RPM). Storage capacities of hard disks for personal computers range from 10 GB to 120 GB (one billion bytes are called a gigabyte).



Figure 4: Hard Disk

IV. Optical Disks: CD-R Drive, CD-RW disks, DVD, Blue ray Discs

Optical Mass Storage Devices Store bit values as variations in light reflection. They have higher area density & longer data life than magnetic storage. They are also Standardized and relatively inexpensive. Their Uses: read-only storage with low performance requirements, applications with high capacity requirements & where portability in a standardized format is needed.

Example of the Optical Drives

- CD's (Compact Disk)

Their storage:

~ 700 MB storage

Their Types:

- CD-ROM (read only)
- CD-R: (record) to a CD
- CD-RW: can write and erase CD to reuse it (re-writable)
- DVD(Digital Video Disk)

CD:

Compact Disk (CD) is portable disk having data storage capacity between 650-700 MB. It can hold large amount of information such as music, full-motion videos, and text etc. It contains digital information that can be read, but cannot be rewritten. Separate drives exist for reading and writing CDs.

Since it is a very reliable storage media, it is very often used as a medium for distributing large amount of information to large number of users. In fact today most of the software is distributed through CDs.

DVD

Digital Versatile Disk (DVD) is similar to a CD but has larger storage capacity and enormous clarity. Depending upon the disk type it can store several Gigabytes of data (as opposed to around 650MB of a CD). DVDs are primarily used to store music or

movies and can be played back on your television or the computer too. They are not rewritable media. Its also termed DVD (Digital Video Disk)

DVD-ROM

- Over 4 GB storage (varies with format)
- DVD- ROM (read only)
- Many recordable formats (e.g., DVD-R, DVD-RW; ..)
- Are more highly compact than a CD.
- Special laser is needed to read them

Blu-ray Technology

The name is derived from the blue-violet laser used to read and write data. It was developed by the Blu-ray Disc Association with more than 180 members. Some companies with the technology are Dell, Sony, LG. The Data capacity is very large because Blu-ray uses a blue laser (405 nanometers) instead of a red laser (650 nanometers) this allows the data tracks on the disc to be very compact. This allows for more than twice as small pits as on a DVD. Because of the greatly compact data Blu-ray can hold almost 5 times more data than a single layer DVD. Close to 25 GB!. Just like a DVD Blu-ray can also be recorded in Dual-Layer format. This allows the disk to hold up to 50 GB!!

The Variations in the formats are as follows:

- BD-ROM (read-only) - for pre-recorded content
- BD-R (recordable) - for PC data storage
- BD-RW (rewritable) - for PC data storage
- BD-RE (rewritable) - for HDTV recording

Summary:

The chapter has introduced the concept of memory units and its categories as the main and the second memory and their characteristic features. It discusses the features of RAM, ROM, PROM, and EPROM. Auxiliary Storage Devices like -Magnetic Tape, Hard Disk, Floppy Disk are also discussed. The chapter concludes with an introduction to the Optical Disks such as CD-R Drive, CD-RW disks, DVD, Blue ray Discs

Chapter 9

Input/Output Devices

Contents:

- I. Introduction
- II. Input Devices
 - a. Keyboard, mouse, joystick, scanners, digital camera, bar code reader, touch screen, speech input device (microphone)
- III. Output Devices
 - a. Monitor, Speaker, Printers (different types)

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I. Introduction

The computer will be of no use unless it is able to communicate with the outside world. Input/Output devices are required for users to communicate with the computer. In simple terms, input devices bring information INTO the computer and output devices bring information OUT of a computer system. These input/output devices are also known as **peripherals** since they surround the CPU and memory of a computer system.

Some commonly used Input/Output devices are listed in table below.

Input Devices	Output Devices
Keyboard	Monitor
Mouse	LCD
Joystick	Printer
Scanner	Plotter
Light Pen	
Touch Screen	

II. Input Devices

(a) Keyboard

It is a text base input device that allows the user to input alphabets, numbers and other characters. It consists of a set of keys mounted on a board.

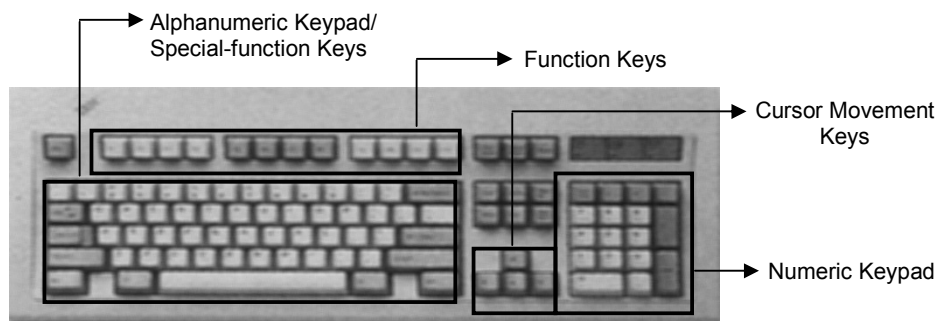


Figure 1: The Keyboard

Alphanumeric Keypad

It consists of keys for English alphabets, 0 to 9 numbers, and special characters like + – / * () etc.

Function Keys

There are twelve function keys labeled F1, F2, F3... F12. The functions assigned to these keys differ from one software package to another. These keys are also user programmable keys.

Special-function Keys

These keys have special functions assigned to them and can be used only for those specific purposes. Functions of some of the important keys are defined below.

Enter

It is similar to the ‘return’ key of the typewriter and is used to execute a command or program.

Spacebar

It is used to enter a space at the current cursor location.

Backspace

This key is used to move the cursor one position to the left and also delete the character in that position.

Delete

It is used to delete the character at the cursor position.

Insert

Insert key is used to toggle between insert and overwrite mode during data entry.

Shift

This key is used to type capital letters when pressed along with an alphabet key. Also used to type the special characters located on the upper-side of a key that has two characters defined on the same key.

Caps Lock

Cap Lock is used to toggle between the capital lock features. When ‘on’, it locks the alphanumeric keypad for capital letters input only.

Tab

Tab is used to move the cursor to the next tab position defined in the document. Also, it is used to insert indentation into a document.

Ctrl

Control key is used in conjunction with other keys to provide additional functionality on the keyboard.

Alt

Also like the control key, Alt key is always used in combination with other keys to perform specific tasks.

Esc

This key is usually used to negate a command. Also used to cancel or abort executing programs.

Numeric Keypad

Numeric keypad is located on the right side of the keyboard and consists of keys having numbers (0 to 9) and mathematical operators (+ – * /) defined on them. This keypad is provided to support quick entry for numeric data.

Cursor Movement Keys

These are arrow keys and are used to move the cursor in the direction indicated by the arrow (up, down, left, right).

(b) Mouse

The mouse is a small device used to point to a particular place on the screen and select in order to perform one or more actions. It can be used to select menu commands, size windows, start programs etc.

The most conventional kind of mouse has two buttons on top: the left one being used most frequently.

Mouse Actions

Left Click : Used to select an item.

Double Click : Used to start a program or open a file.

Right Click : Usually used to display a set of commands.

Drag and Drop : It allows you to select and move an item from one location to another. To achieve this place the cursor over an item on the screen, click the left mouse button and while holding the button down move the cursor to where you want to place the item, and then release it.



Figure 2: The Mouse

(c) Joystick

The joystick is a vertical stick which moves the graphic cursor in a direction the stick is moved. It typically has a button on top that is used to select the option pointed by the cursor. Joystick is used as an input device primarily used with video games, training simulators and controlling robots



Figure 3: The Joystick

(d)Scanner

Scanner is an input device used for direct data entry from the source document into the computer system. It converts the document image into digital form so that it can be fed into the computer. Capturing information like this reduces the possibility of errors typically experienced during large data entry.



Figure 4: The Scanner

Hand-held scanners are commonly seen in big stores to scan codes and price information for each of the items. They are also termed the bar code readers.

(e) Bar codes

A bar code is a set of lines of different thicknesses that represent a number. Bar Code Readers are used to input data from bar codes. Most products in shops have bar codes on them. Bar code readers work by shining a beam of light on the lines that make up the bar code and detecting the amount of light that is reflected back.



Figure 5: The Bar Code Reader

(f) Light Pen

It is a pen shaped device used to select objects on a display screen. It is quite like the mouse (in its functionality) but uses a light pen to move the pointer and select any object on the screen by pointing to the object.

Users of Computer Aided Design (CAD) applications commonly use the light pens to directly draw on screen.

(g) Touch Screen

It allows the user to operate/make selections by simply touching the display screen. Common examples of touch screen include information kiosks, and bank ATMs.

(h) Digital camera

A **digital camera** can store many more pictures than an ordinary camera. Pictures taken using a digital camera are stored inside its memory and can be transferred to a computer by connecting the camera to it. A digital camera takes pictures by converting the light passing through the lens at the front into a digital image.



Figure 6: The Digital camera

(i) The Speech Input Device

The “Microphones - Speech Recognition” is a speech Input device. To operate it we require using a microphone to talk to the computer. Also we need to add a sound card to the computer. The Sound card digitizes audio input into 0/1s. A speech recognition program can process the input and convert it into machine-recognized commands or input.

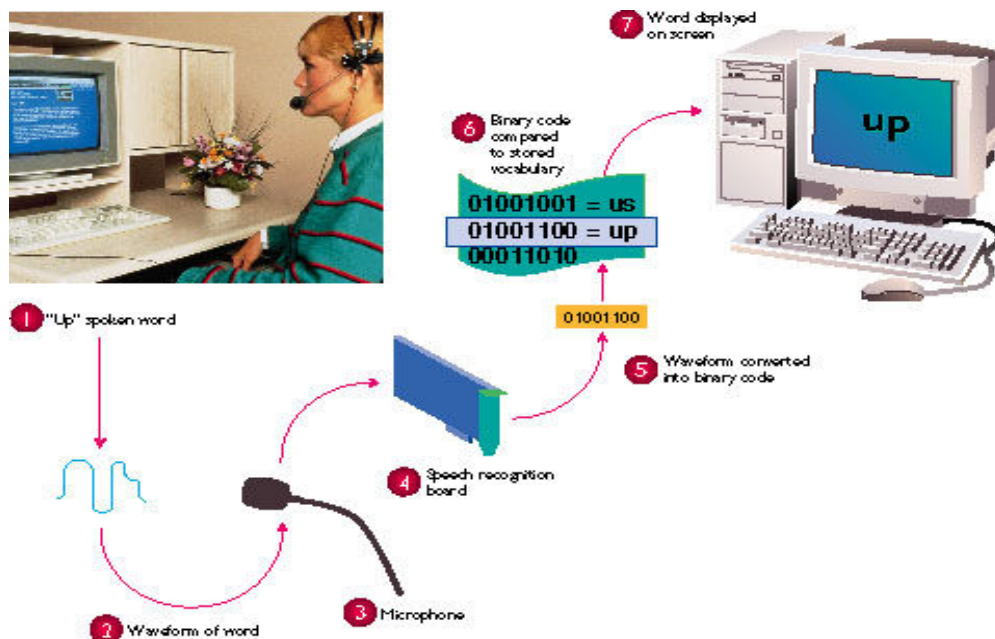


Figure 7: The Microphone

III. Output Devices

(a) Monitor

Monitor is an output device that resembles the television screen and uses a Cathode Ray Tube (CRT) to display information. The monitor is associated with a keyboard for manual input of characters and displays the information as it is keyed in. It also displays the program or application output. Like the television, monitors are also available in different sizes.

(b) Liquid Crystal Display (LCD)

LCD was introduced in the 1970s and is now applied to display terminals also. Its advantages like low energy consumption, smaller and lighter have paved its way for usage in portable computers (laptops).



Figure 8: The LCD

(c) Printer

Printers are used to produce paper (commonly known as hardcopy) output. Based on the technology used, they can be classified as **Impact** or **Non-impact** printers.

Impact printers use the typewriting printing mechanism wherein a hammer strikes the paper through a ribbon in order to produce output. Dot-matrix and Character printers fall under this category.

Non-impact printers do not touch the paper while printing. They use chemical, heat or electrical signals to etch the symbols on paper. Inkjet, Deskjet, Laser, Thermal printers fall under this category of printers.

When we talk about printers we refer to two basic qualities associated with printers: resolution, and speed. **Print resolution** is measured in terms of number of dots per inch (dpi). **Print speed** is measured in terms of number of characters printed in a unit of time and is represented as characters-per-second (cps), lines-per-minute (lpm), or pages-per-minute (ppm).



Figure 9: The Printer

(d) Plotter

Plotters are used to print graphical output on paper. It interprets computer commands and makes line drawings on paper using multicolored automated pens. It is capable of producing graphs, drawings, charts, maps etc.

Computer Aided Engineering (CAE) applications like CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) are typical usage areas for plotters.

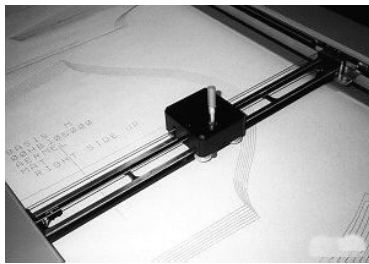


Figure 10: The Plotter

(e) Audio Output: Sound Cards and Speakers:

The Audio output is the ability of the computer to output sound. Two components are needed: Sound card – Plays contents of digitized recordings, Speakers – Attached to sound card.

Summary:

The Chapter has given an introduction to the Input/Output devices. It gives a detailed listing of the various types of input devices and the output device. The concepts are also very clearly understood by seeing at the figures in the chapter.



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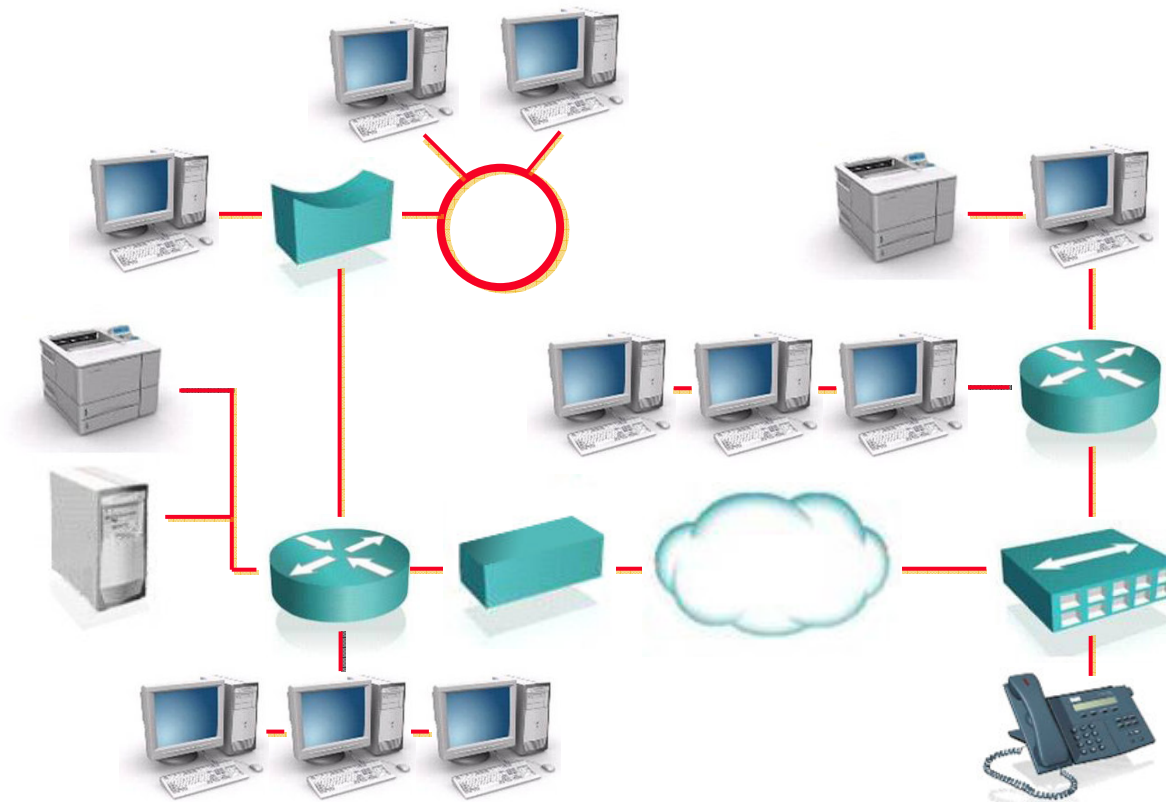
Networking Fundamentals

Objectives

- **Describe the function and operation of a hub, a switch and a router**
- **Describe the function and operation of a firewall and a gateway**
- **Describe the function and operation of Layer 2 switching, Layer 3 switching, and routing**
- **Identify the layers of the OSI model**
- **Describe the functionality of LAN, MAN, and WAN networks**
- **Identify the possible media types for LAN and WAN connections**

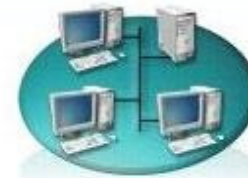
What is a Network?

- A network refers to two or more connected computers that can share resources such as data, a printer, an Internet connection, applications, or a combination of these resources.

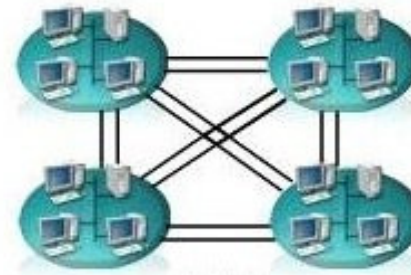


Types of Networks

Local Area Network (LAN)



Metropolitan Area Network (MAN)

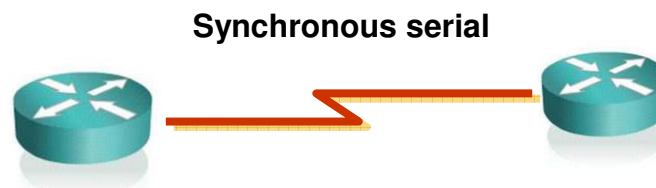


Wide Area Network (WAN)

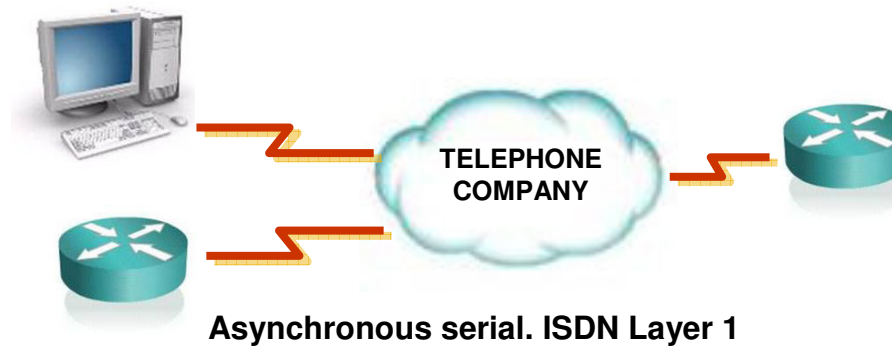


WAN Technologies

Leased Line



Circuit-switched



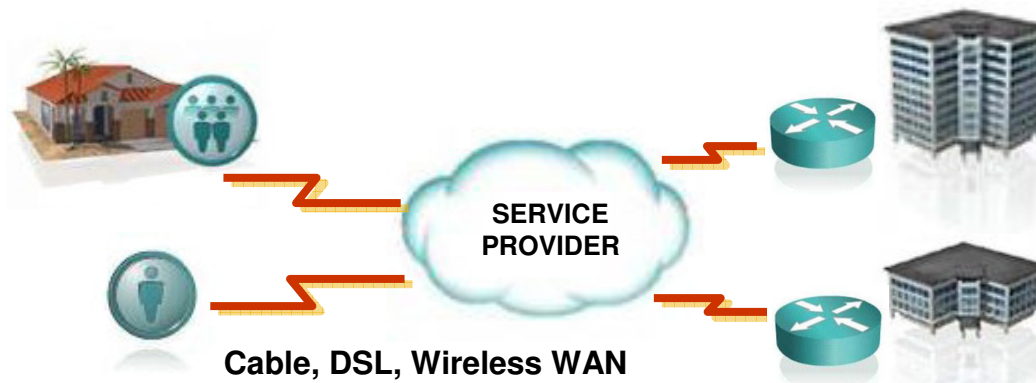
WAN Technologies (Cont.)

Frame-Relay

Synchronous serial



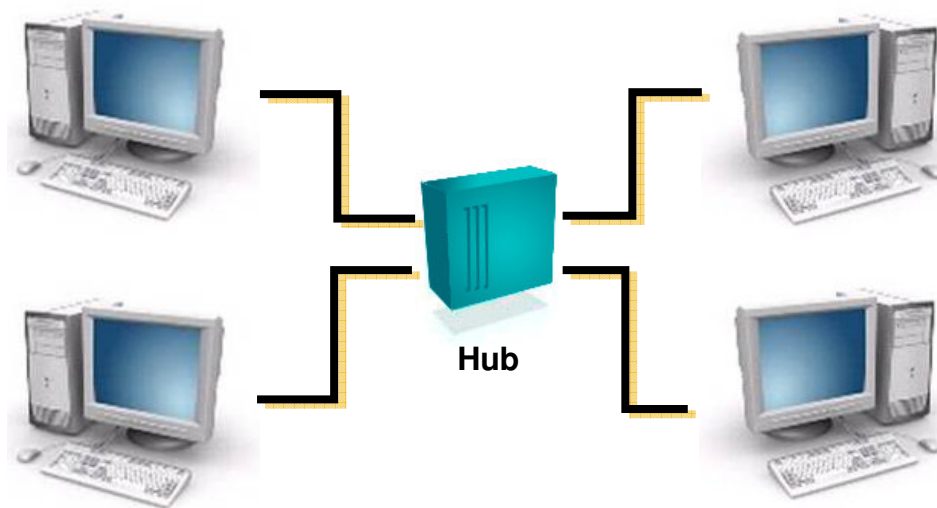
Broadband Access



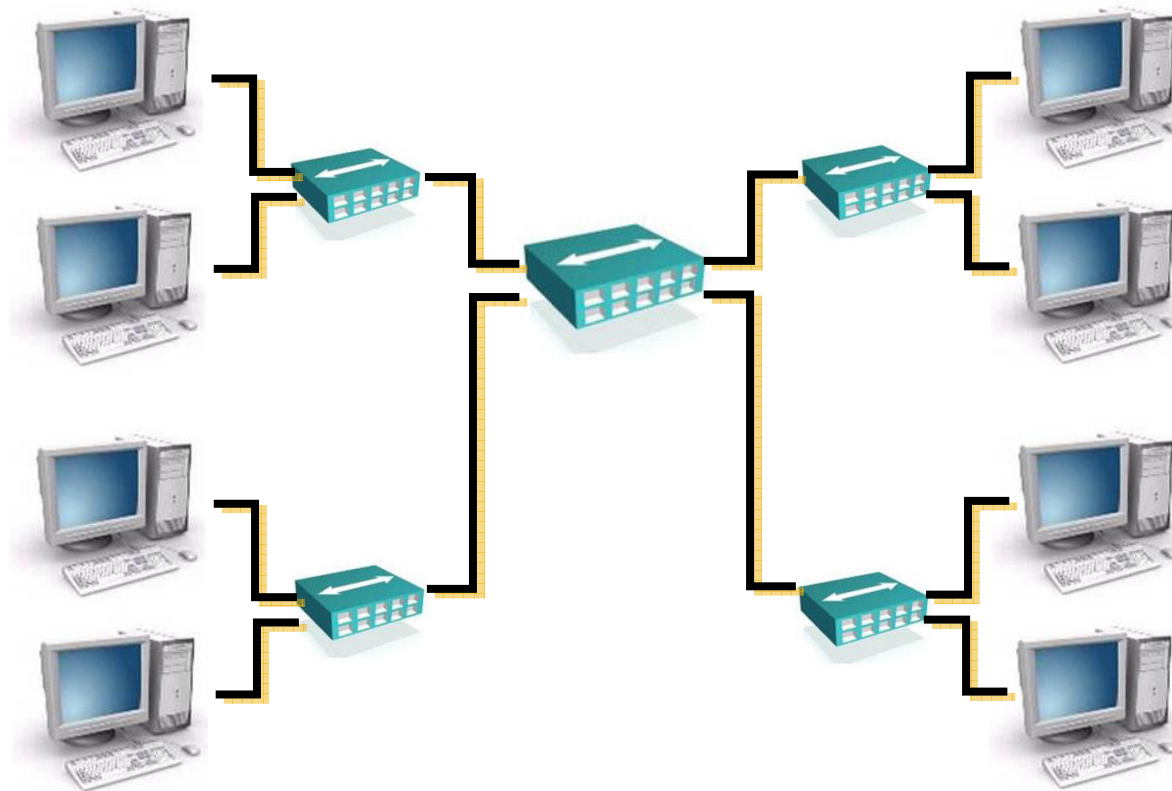
Network Topologies: Bus Topology



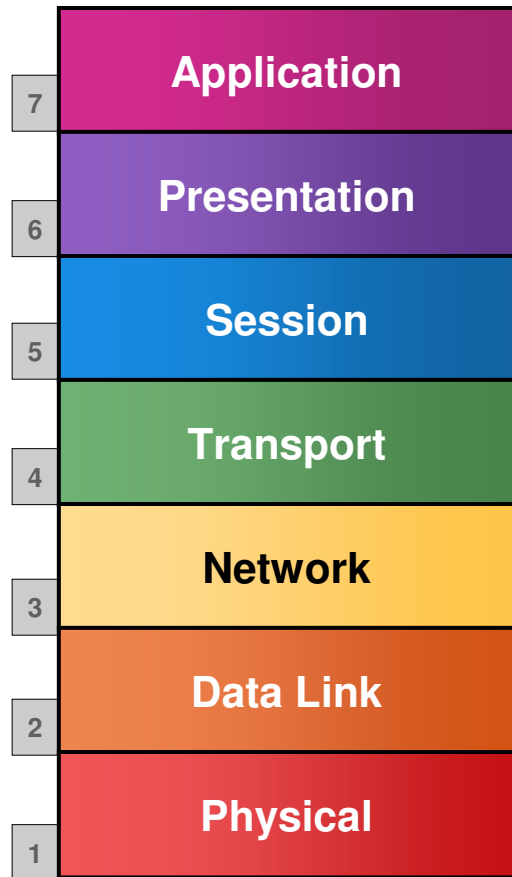
Network Topologies: Star Topology



Network Topologies: Extended Star Topology

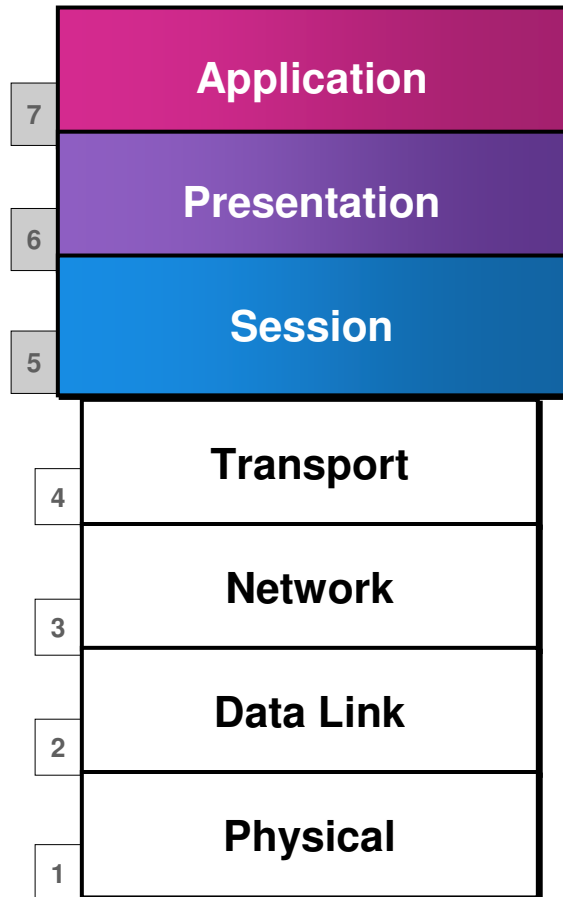


The OSI Model— Why a Layered Network Model?



- **Reduces complexity**
- **Standardizes interfaces**
- **Facilitates modular engineering**
- **Ensures interoperable technology**
- **Accelerates evolution**
- **Simplifies teaching and learning**

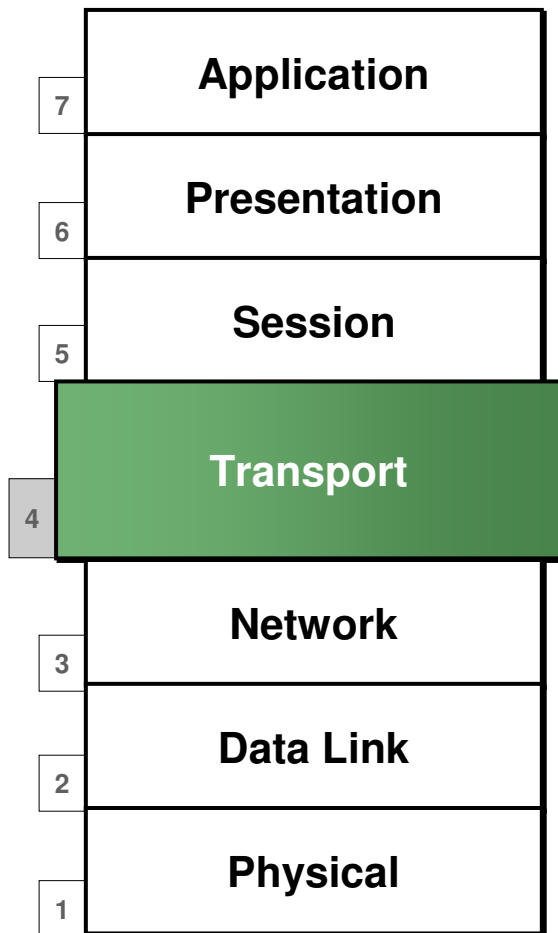
The Seven Layers of the OSI Model



Application Layers (Upper Layers):

- Network Processes to Applications
- Data Representation
- InterHost Communication

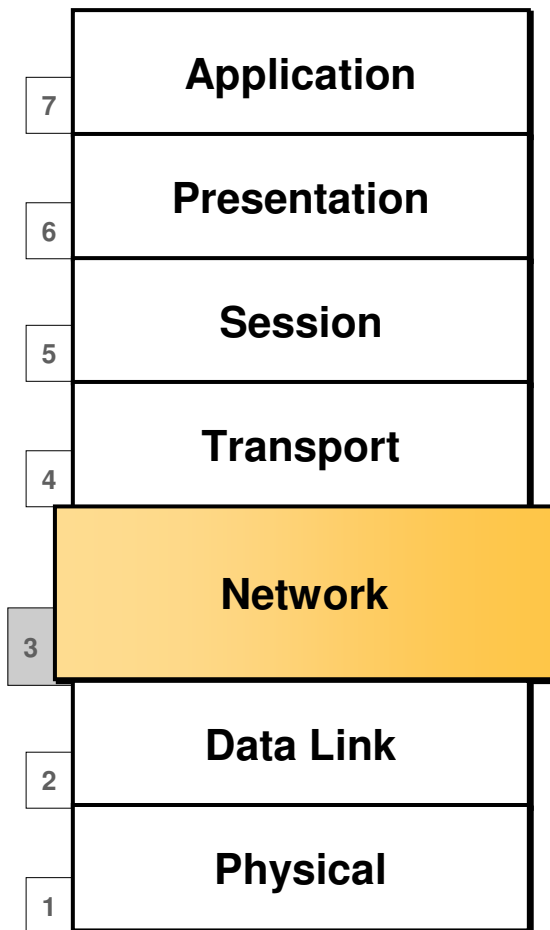
The Seven Layers of the OSI Model (Cont.)



End To End Connections:

- Handles transportation issues between hosts
- Ensures data transport reliability
- Establishes, maintains and terminates virtual circuits
- Provides reliability through fault detection and recovery
- Information flow control

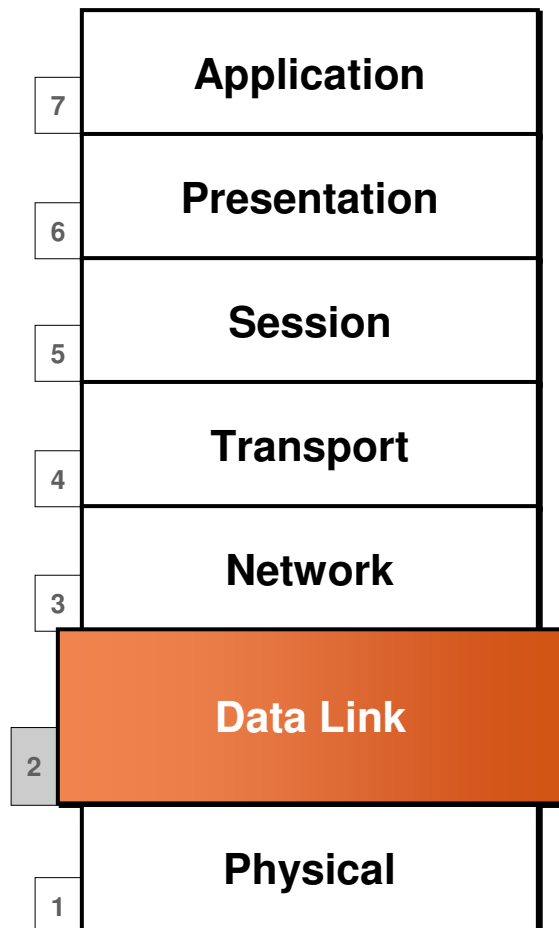
The Seven Layers of the OSI Model (Cont.)



Data Delivery:

- Provides connectivity and path selection between two host systems
- Routes data packets
- Selects best path to deliver data
- The Network layer prioritizes data known as Quality of Service (QoS)

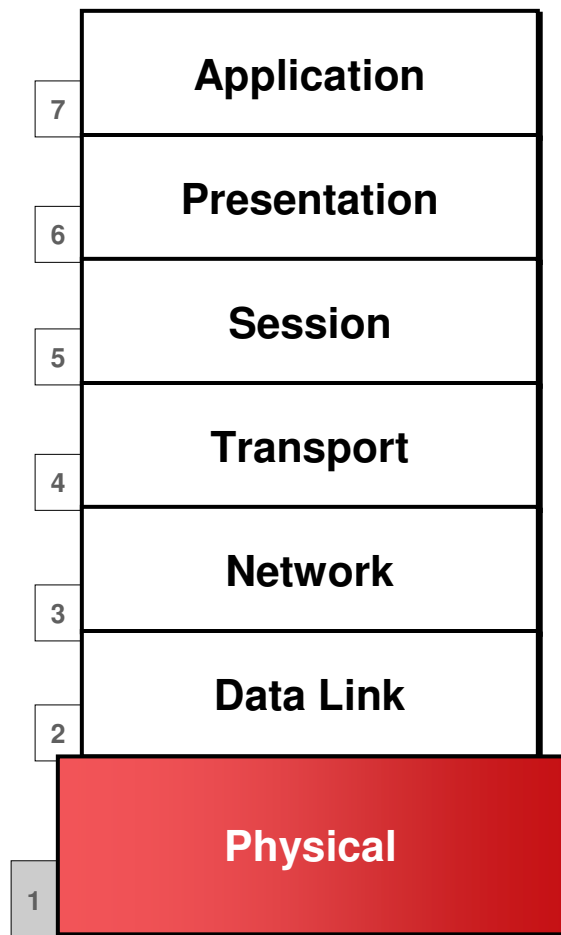
The Seven Layers of the OSI Model (Cont.)



Access to Media:

- Defines how data is formatted for transmission and how access to the network is controlled

The Seven Layers of the OSI Model (Cont.)

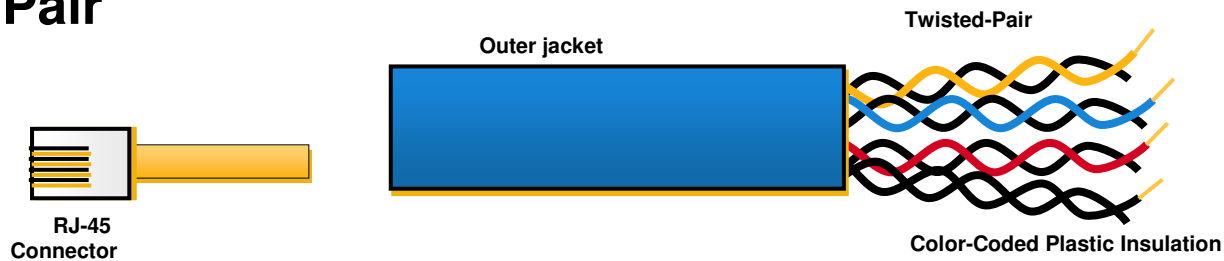


Binary Transmission:

- Defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the physical link

Physical Media Types

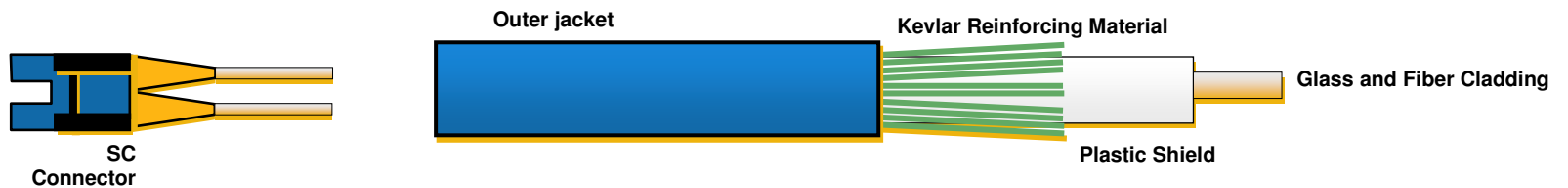
Twisted-Pair



Coaxial

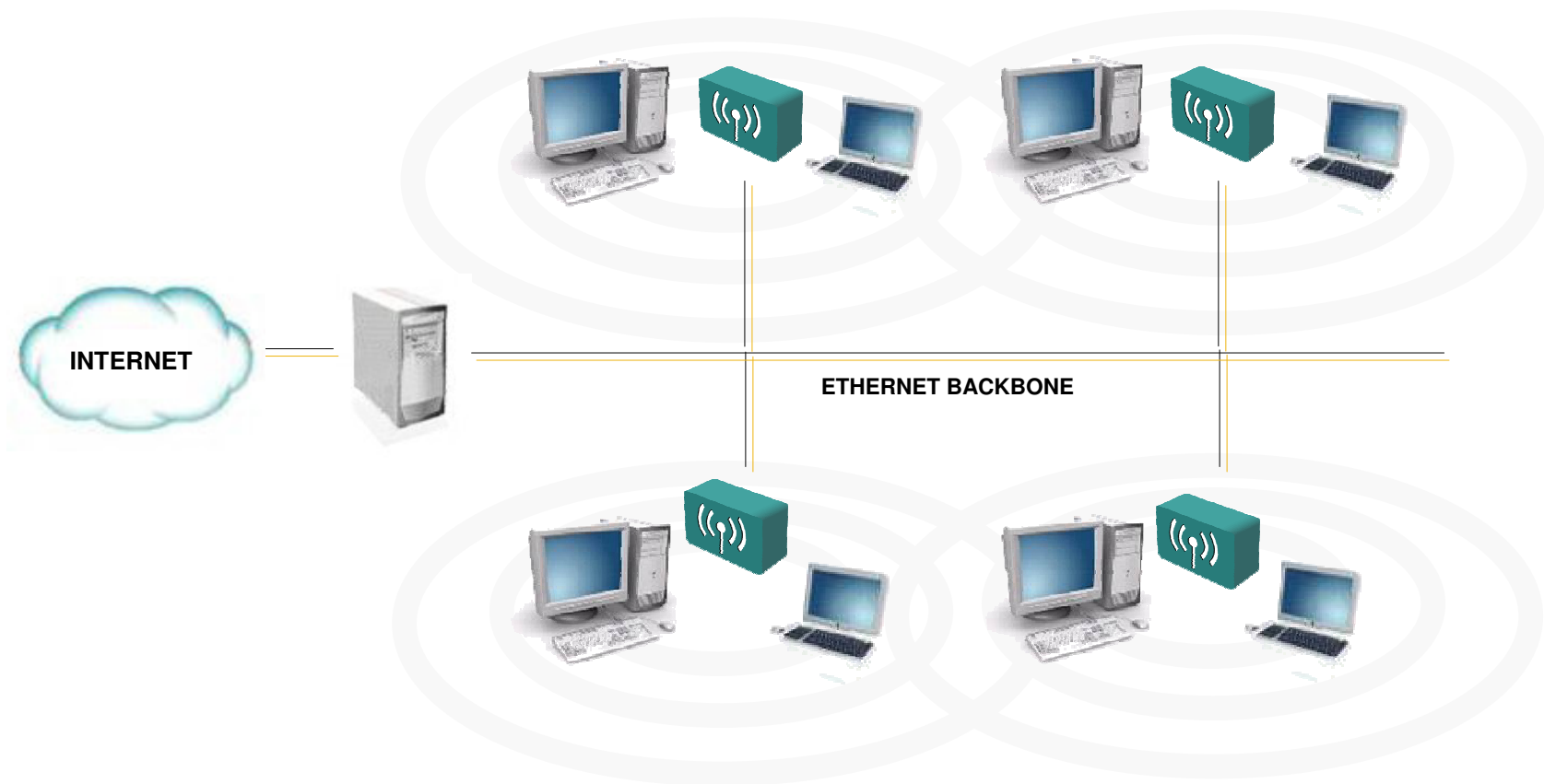


Fiber Optics



Physical Media Types (Cont.)

Wireless

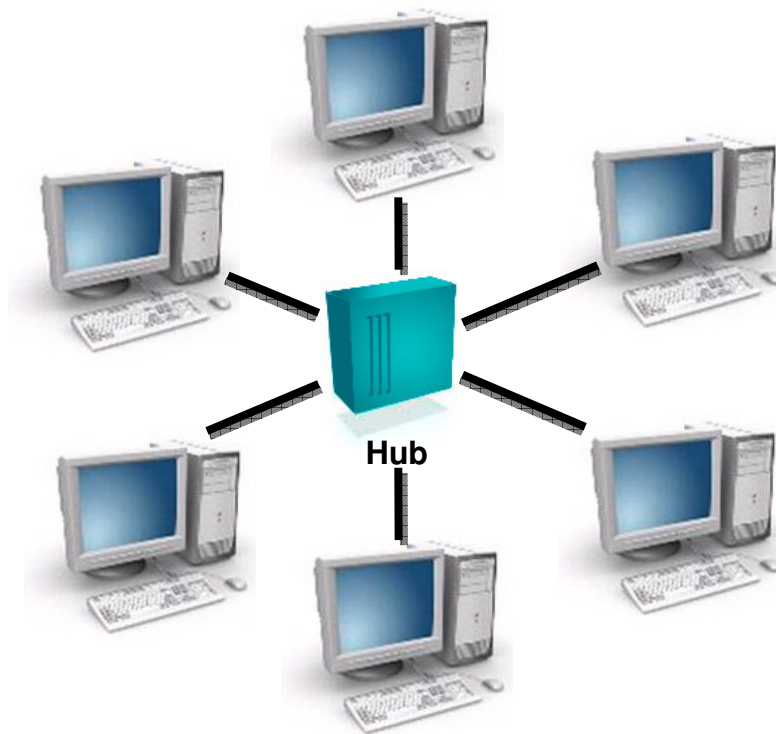


Physical Media Comparison

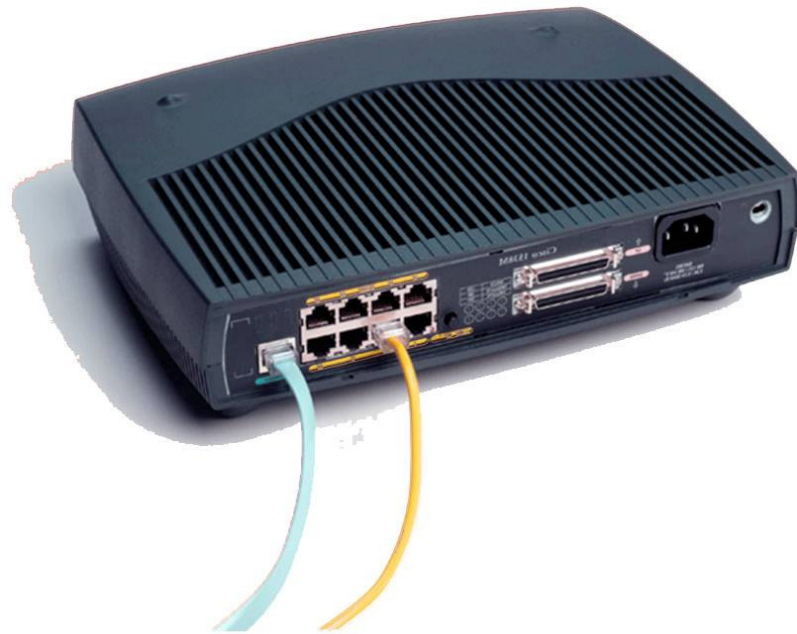
	Twisted Pair	Coaxial	Fiber Optic	Wireless LAN
Bandwidth	Up to 1 Gbps	10–100 Mbps	Up to 10 Gbps or higher	Up to 54 Mbps
Distance	Up to 100 m	Up to 500 m	Up to 60 km	Up to 100 m
Price	Least expensive	Inexpensive	Most expensive	Moderate

Hub or Repeater

- A hub (concentrator) is a device that repeats the signals it receives on one port to all other ports. It is a central connection point for several network devices.



Hub (Multiport Repeater)



Network Interface Card



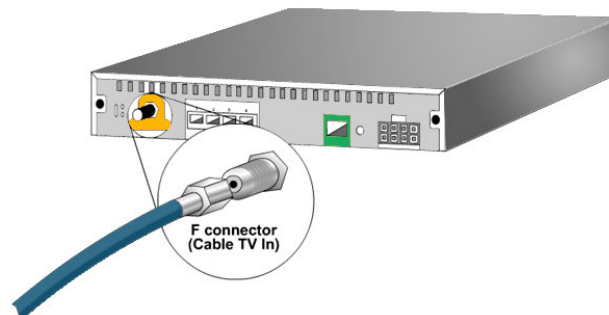
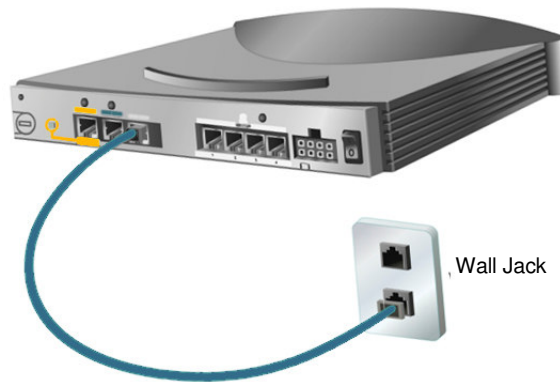
WAN—Physical Layer Implementations

- Physical layer implementations vary
- Cable specifications define speed of link

Cisco HDLC	PPP	Frame Relay	ISDN BRI (with PPP)	DSL Modem	Cable Modem
EIA/TIA-232 EIA/TIA-449 X.21 V.24 V.35 HSSI			RJ-48 Note: ISDN BRI cable pinouts are different than the pinouts for Ethernet. The RJ-48 and RJ-45 look the same, but the pinouts are different.	RJ-11 Note: Works over telephone line	BNC Note: Works over Cable TV line

WAN

Physical Media



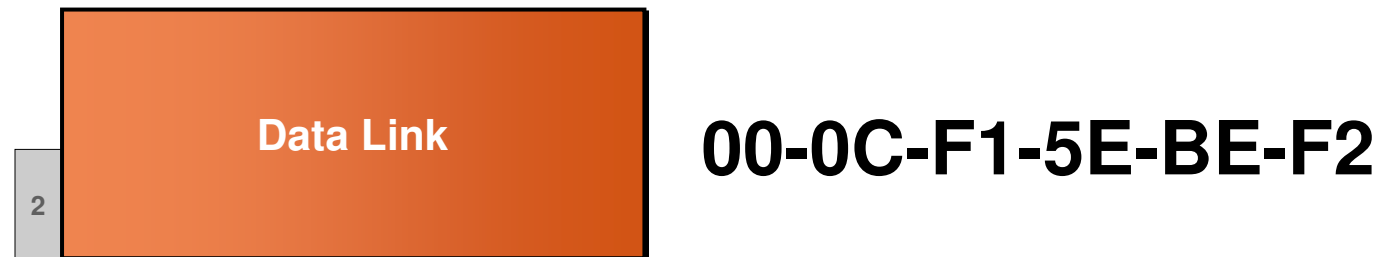
Data Link Layer

- **Data Link layer protocols create, transmit, and receive packets. This layer is also responsible for logical MAC addressing and LLC processing, creating logical topologies, and controlling media access.**



MAC Address

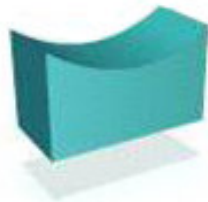
- The network interface card address, called the hardware address, is protocol-independent and is usually assigned at the factory. This address is technically called the media access control address (MAC) because it is found on the MAC sub layer of the Data Link layer.



MAC Address = Hardware Address

Data Link Devices

- The Data Link layer is manipulated by two devices: bridges and switches. These are more complex and more expensive than their Physical layer counterparts, but they do have advantages.



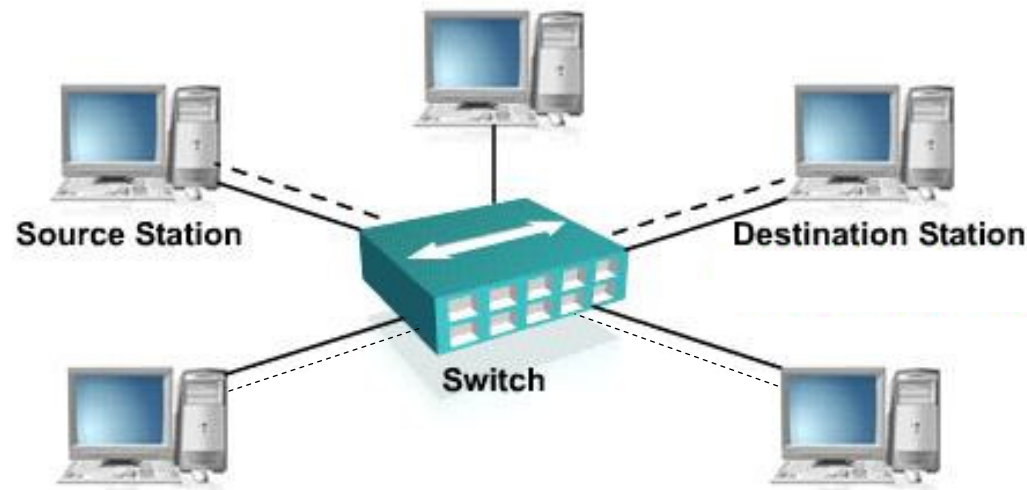
Bridges



Switches

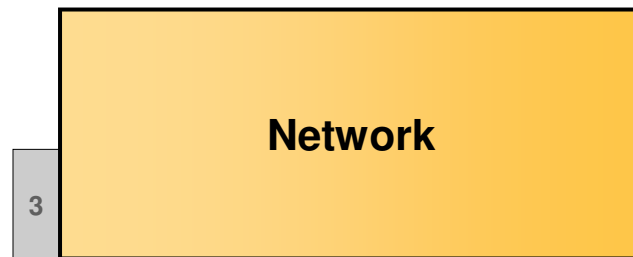
Switch

- When a switch receives data the switch examines the data link header for the MAC address of the destination station and forwards it to the correct port. This opens a path between ports that can use the full bandwidth of the topology.



Network Layer

- The network layer provides connectivity and path selection between two host systems that may be located on geographically separated networks



Network Layer (Cont.)

- **IP is a standard that defines the manner in which the network layers of two hosts interact. IP addresses are 32 bit long, hierarchical addressing scheme.**



IP Address = Logical Address

Network Layer Devices

- The devices that operate at the Network layer are routers and Layer 3 Switches



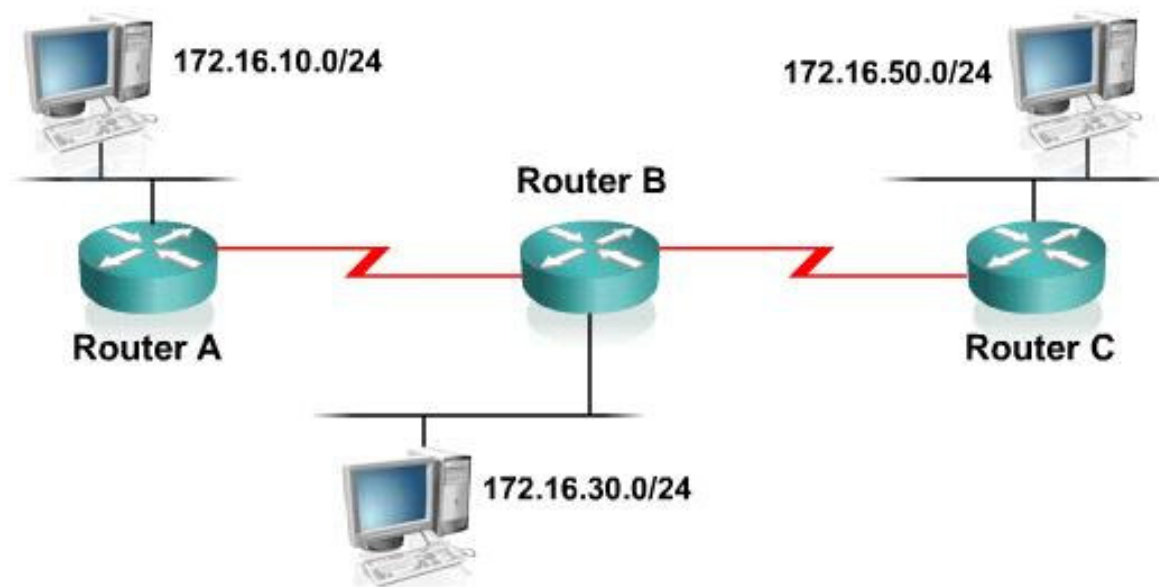
Router



Layer 3 Switch

Routers

- **Routers facilitate communication within this internet work. It decides how to send packets within the network so that they arrive at their destination.**



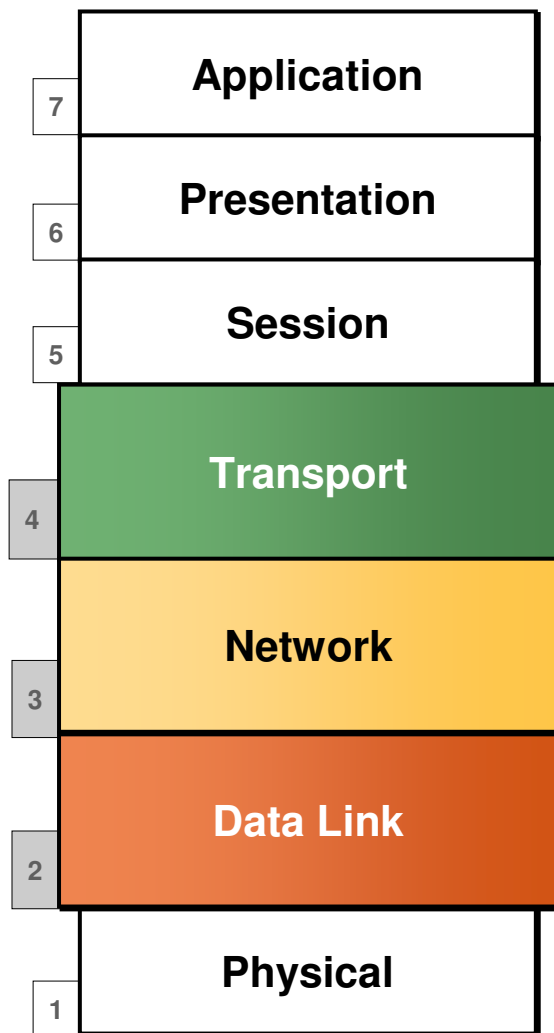
Layer 3 Switches

- The Layer 3 switch functions at the Network layer and performs the multiport, virtual LAN, data pipelining functions of a standard Layer 2 switch. It can also perform basic routing functions between virtual LANs.

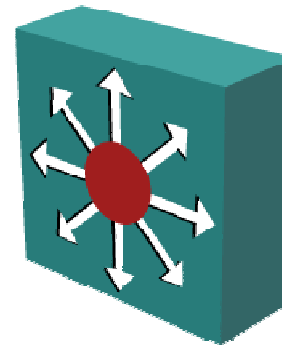


Layer 3 Switch

Multilayer Switching

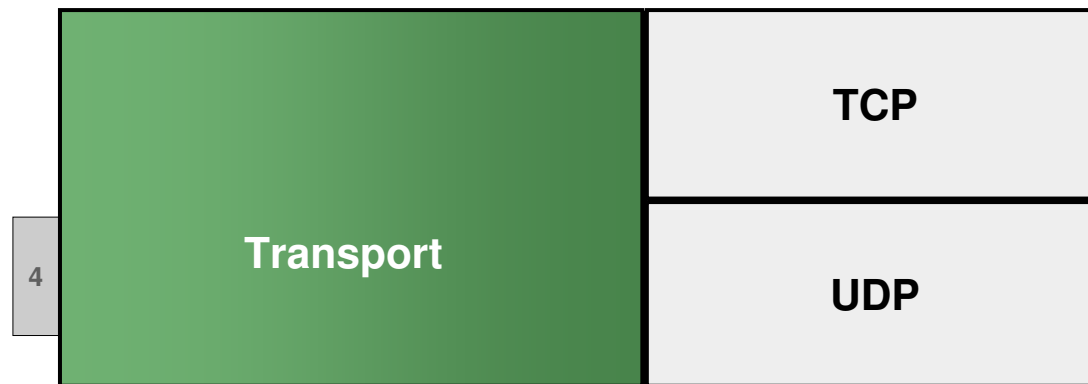


- **Combines functionality of:**
 - Layer 2 switching
 - Layer 3 switching
 - Layer 4 switching
- **High-speed scalability**
- **Low latency compared to routers**



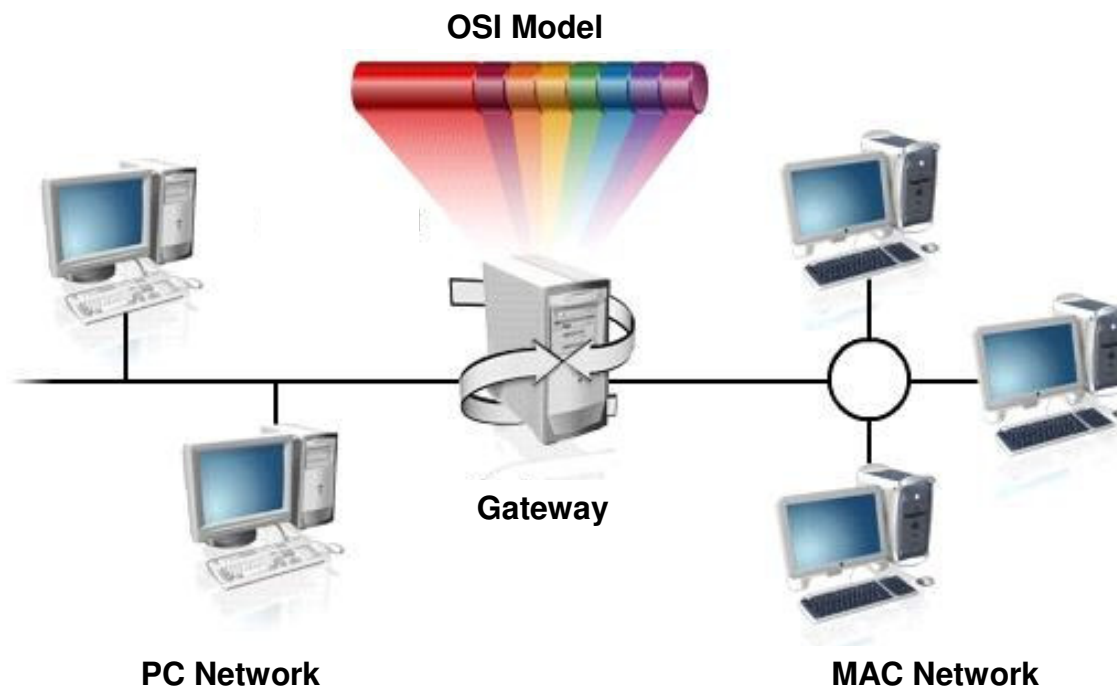
Transport Layer Implementations

- The Transport layer is charge of the reliable/unreliable transport of data. It can be implemented as TCP or UDP.



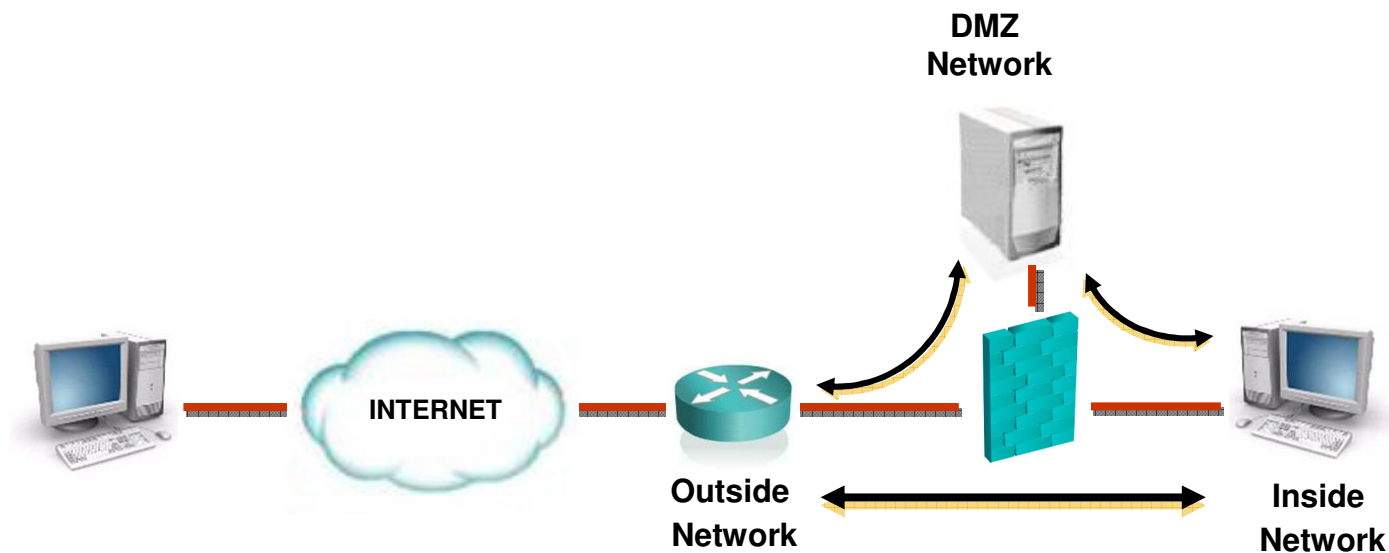
Gateway

- A gateway is a combination of hardware and software that connects dissimilar network environments. It performs translations at multiple layers of the open system interconnection (OSI) model.



Firewalls

- A firewall is a system or group of systems that manages access between two or more networks



Summary

This lesson covered the following main topics:

- **The function and operation of a hub, a switch, and a router**
- **The function and operation of Layer 2 switching, Layer 3 switching, and routing**
- **The OSI model**
- **Functionality of LAN, MAN and WAN networks**
- **Possible media types for LAN and WAN connections**
- **The function and definition of firewalls and gateways**





Computer Fundamentals

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About the Tutorial

Computer is an advanced electronic device that takes raw data as an input from the user and processes it under the control of a set of instructions (called program), produces a result (output), and saves it for future use.

This tutorial explains the foundational concepts of computer hardware, software, operating systems, peripherals, etc. along with how to get the most value and impact from computer technology.

Audience

This tutorial has been prepared for beginners as well as advanced learners who want to deal with computers. The tutorial is also very useful for undergraduate students of computer science, engineering, business administration, management, science, commerce and arts, where an introductory course on computers is a part of curriculum.

After completing this tutorial, you will find yourself at a moderate level of expertise in the knowledge of computer basics from where you can take yourself to the next level.

Prerequisites

Knowledge of computers is not a prerequisite to follow the contents of this tutorial. This tutorial assumes no background in Computers or Computer programming.

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1. Computer Fundamentals – Overview

Today's world is an information-rich world and it has become a necessity for everyone to know about computers. A computer is an electronic data processing device, which accepts and stores data input, processes the data input, and generates the output in a required format.

The purpose of this tutorial is to introduce you to Computers and its fundamentals.

Functionalities of a Computer

If we look at it in a very broad sense, any digital computer carries out the following five functions:

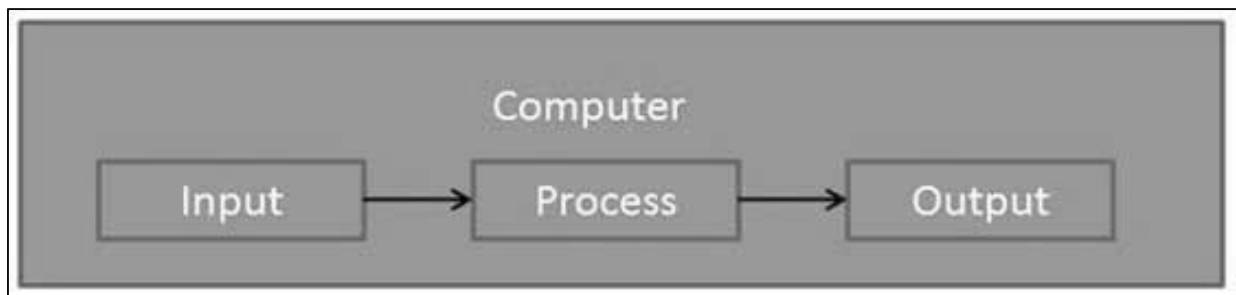
Step 1 - Takes data as input.

Step 2 - Stores the data/instructions in its memory and uses them as required.

Step 3 - Processes the data and converts it into useful information.

Step 4 - Generates the output.

Step 5 - Controls all the above four steps.



Advantages of Computers

Following are certain advantages of computers.

High Speed

- Computer is a very fast device.
- It is capable of performing calculation of very large amount of data.
- The computer has units of speed in microsecond, nanosecond, and even the picosecond.

- It can perform millions of calculations in a few seconds as compared to man who will spend many months to perform the same task.

Accuracy

- In addition to being very fast, computers are very accurate.
- The calculations are 100% error free.
- Computers perform all jobs with 100% accuracy provided that the input is correct.

Storage Capability

- Memory is a very important characteristic of computers.
- A computer has much more storage capacity than human beings.
- It can store large amount of data.
- It can store any type of data such as images, videos, text, audio, etc.

Diligence

- Unlike human beings, a computer is free from monotony, tiredness, and lack of concentration.
- It can work continuously without any error and boredom.
- It can perform repeated tasks with the same speed and accuracy.

Versatility

- A computer is a very versatile machine.
- A computer is very flexible in performing the jobs to be done.
- This machine can be used to solve the problems related to various fields.
- At one instance, it may be solving a complex scientific problem and the very next moment it may be playing a card game.

Reliability

- A computer is a reliable machine.
- Modern electronic components have long lives.

- Computers are designed to make maintenance easy.

Automation

- Computer is an automatic machine.
- Automation is the ability to perform a given task automatically. Once the computer receives a program i.e., the program is stored in the computer memory, then the program and instruction can control the program execution without human interaction.

Reduction in Paper Work and Cost

- The use of computers for data processing in an organization leads to reduction in paper work and results in speeding up the process.
- As data in electronic files can be retrieved as and when required, the problem of maintenance of large number of paper files gets reduced.
- Though the initial investment for installing a computer is high, it substantially reduces the cost of each of its transaction.

Disadvantages of Computers

Following are certain disadvantages of computers.

No I.Q.

- A computer is a machine that has no intelligence to perform any task.
- Each instruction has to be given to the computer.
- A computer cannot take any decision on its own.

Dependency

- It functions as per the user's instruction, thus it is fully dependent on humans.

Environment

- The operating environment of the computer should be dust free and suitable.

No Feeling

- Computers have no feelings or emotions.
- It cannot make judgment based on feeling, taste, experience, and knowledge unlike humans.

2. Computer Fundamentals – Applications

In this chapter, we will discuss the application of computers in various fields.

Business

A computer has high speed of calculation, diligence, accuracy, reliability, or versatility which has made it an integrated part in all business organizations.

Computer is used in business organizations for:

- Payroll calculations
- Budgeting
- Sales analysis
- Financial forecasting
- Managing employee database
- Maintenance of stocks, etc.



Banking

Today, banking is almost totally dependent on computers.

Banks provide the following facilities:

- Online accounting facility, which includes checking current balance, making deposits and overdrafts, checking interest charges, shares, and trustee records.
- ATM machines which are completely automated are making it even easier for customers to deal with banks.



Insurance

Insurance companies are keeping all records up-to-date with the help of computers. Insurance companies, finance houses, and stock broking firms are widely using computers for their concerns.

Insurance companies are maintaining a database of all clients with information showing:

- Procedure to continue with policies
- Starting date of the policies
- Next due installment of a policy
- Maturity date
- Interests due
- Survival benefits
- Bonus



Education

The computer helps in providing a lot of facilities in the education system.

- The computer provides a tool in the education system known as CBE (Computer Based Education).
- CBE involves control, delivery, and evaluation of learning.
- Computer education is rapidly increasing the graph of number of computer students.
- There are a number of methods in which educational institutions can use a computer to educate the students.
- It is used to prepare a database about performance of a student and analysis is carried out on this basis.



Marketing

In marketing, uses of the computer are following:

- **Advertising** - With computers, advertising professionals create art and graphics, write and revise copy, and print and disseminate ads with the goal of selling more products.
- **Home Shopping** - Home shopping has been made possible through the use of computerized catalogues that provide access to product information and permit direct entry of orders to be filled by the customers.



Healthcare

Computers have become an important part in hospitals, labs, and dispensaries. They are being used in hospitals to keep the record of patients and medicines. It is also used in scanning and diagnosing different diseases. ECG, EEG, ultrasounds and CT scans, etc. are also done by computerized machines.

Following are some major fields of health care in which computers are used.

- **Diagnostic System** - Computers are used to collect data and identify the cause of illness.
- **Lab-diagnostic System** - All tests can be done and the reports are prepared by computer.
- **Patient Monitoring System** - These are used to check the patient's signs for abnormality such as in Cardiac Arrest, ECG, etc.
- **Pharma Information System** - Computer is used to check drug labels, expiry dates, harmful side effects, etc.
- **Surgery** - Nowadays, computers are also used in performing surgery.

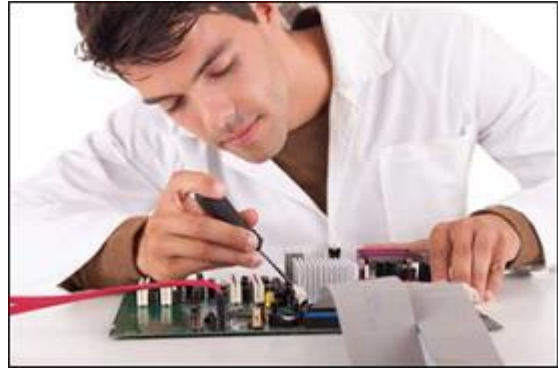


Engineering Design

Computers are widely used for Engineering purpose.

One of the major areas is CAD (Computer Aided Design) that provides creation and modification of images. Some of the fields are:

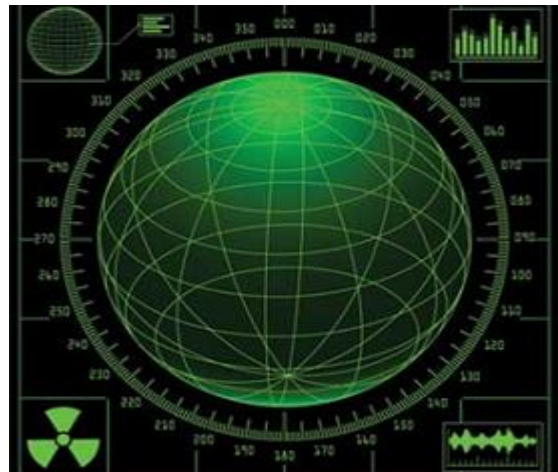
- **Structural Engineering** - Requires stress and strain analysis for design of ships, buildings, bridges, airplanes, etc.
- **Industrial Engineering** - Computers deal with design, implementation, and improvement of integrated systems of people, materials, and equipment.
- **Architectural Engineering** - Computers help in planning towns, designing buildings, determining a range of buildings on a site using both 2D and 3D drawings.



Military

Computers are largely used in defence. Modern tanks, missiles, weapons, etc. Military also employs computerized control systems. Some military areas where a computer has been used are:

- Missile Control
- Military Communication
- Military Operation and Planning
- Smart Weapons



Communication

Communication is a way to convey a message, an idea, a picture, or speech that is received and understood clearly and correctly by the person for whom it is meant. Some main areas in this category are:

- E-mail
- Chatting
- Usenet
- FTP
- Telnet
- Video-conferencing



Government

Computers play an important role in government services. Some major fields in this category are:

- Budgets
- Sales tax department
- Income tax department
- Computation of male/female ratio
- Computerization of voters lists
- Computerization of PAN card
- Weather forecasting



3. Computer Fundamentals – Generations

Generation in computer terminology is a change in technology a computer is/was being used. Initially, the generation term was used to distinguish between varying hardware technologies. Nowadays, generation includes both hardware and software, which together make up an entire computer system.

There are five computer generations known till date. Each generation has been discussed in detail along with their time period and characteristics. In the following table, approximate dates against each generation has been mentioned, which are normally accepted.

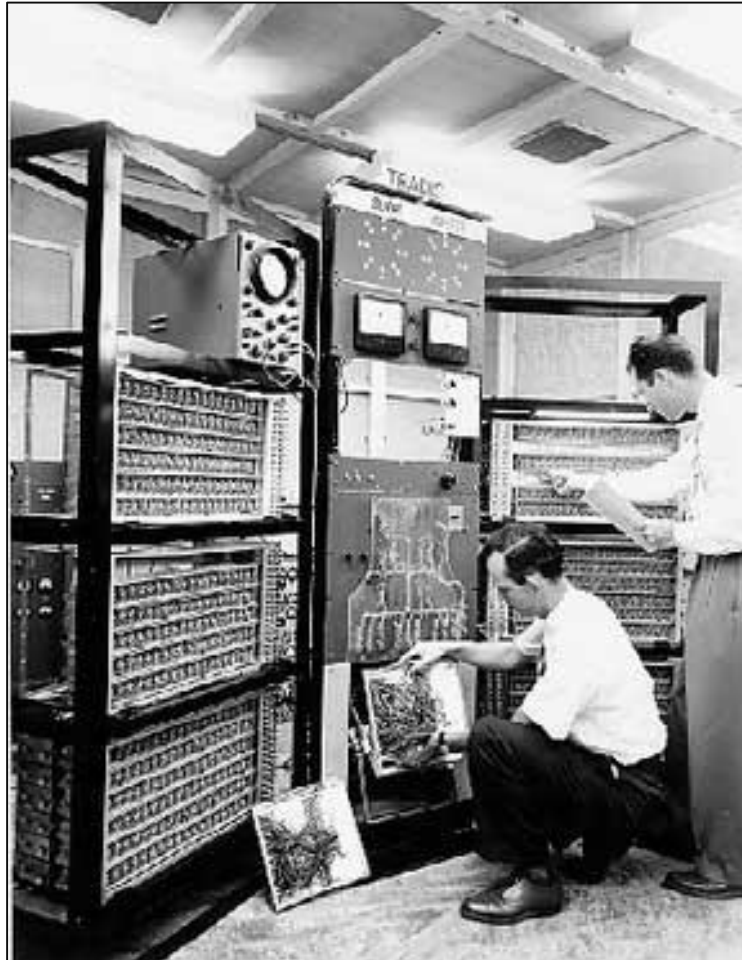
Following are the main five generations of computers.

Sr. No.	Generation & Description
1	<u>First Generation</u> The period of first generation: 1946-1959. Vacuum tube based.
2	<u>Second Generation</u> The period of second generation: 1959-1965. Transistor based.
3	<u>Third Generation</u> The period of third generation: 1965-1971. Integrated Circuit based.
4	<u>Fourth Generation</u> The period of fourth generation: 1971-1980. VLSI microprocessor based.
5	<u>Fifth Generation</u> The period of fifth generation: 1980-onwards. ULSI microprocessor based.

First Generation Computers

The period of first generation was from 1946-1959. The computers of first generation used vacuum tubes as the basic components for memory and circuitry for CPU (Central Processing Unit). These tubes, like electric bulbs, produced a lot of heat and the installations used to fuse frequently. Therefore, they were very expensive and only large organizations were able to afford it.

In this generation, mainly batch processing operating system was used. Punch cards, paper tape, and magnetic tape was used as input and output devices. The computers in this generation used machine code as the programming language.



The main features of the first generation are:

- Vacuum tube technology
- Unreliable
- Supported machine language only
- Very costly
- Generated a lot of heat
- Slow input and output devices
- Huge size
- Need of AC

- Non-portable
- Consumed a lot of electricity

Some computers of this generation were:

- ENIAC
- EDVAC
- UNIVAC
- IBM-701
- IBM-650

Second Generation Computers

The period of second generation was from 1959-1965. In this generation, transistors were used that were cheaper, consumed less power, more compact in size, more reliable and faster than the first generation machines made of vacuum tubes. In this generation, magnetic cores were used as the primary memory and magnetic tape and magnetic disks as secondary storage devices.

In this generation, assembly language and high-level programming languages like FORTRAN, COBOL were used. The computers used batch processing and multiprogramming operating system.



The main features of second generation are:

- Use of transistors
- Reliable in comparison to first generation computers
- Smaller size as compared to first generation computers
- Generated less heat as compared to first generation computers
- Consumed less electricity as compared to first generation computers
- Faster than first generation computers
- Still very costly
- AC required
- Supported machine and assembly languages

Some computers of this generation were:

- IBM 1620
- IBM 7094
- CDC 1604
- CDC 3600
- UNIVAC 1108

Third Generation Computers

The period of third generation was from 1965-1971. The computers of third generation used Integrated Circuits (ICs) in place of transistors. A single IC has many transistors, resistors, and capacitors along with the associated circuitry.

The IC was invented by Jack Kilby. This development made computers smaller in size, reliable, and efficient. In this generation remote processing, time-sharing, multi-programming operating system were used. High-level languages (FORTRAN-II TO IV, COBOL, PASCAL PL/1, BASIC, ALGOL-68 etc.) were used during this generation.



The main features of third generation are:

- IC used
- More reliable in comparison to previous two generations
- Smaller size
- Generated less heat
- Faster
- Lesser maintenance
- Costly
- AC required
- Consumed lesser electricity
- Supported high-level language

Some computers of this generation were:

- IBM-360 series
- Honeywell-6000 series
- PDP (Personal Data Processor)
- IBM-370/168
- TDC-316

Fourth Generation Computers

The period of fourth generation was from 1971-1980. Computers of fourth generation used Very Large Scale Integrated (VLSI) circuits. VLSI circuits having about 5000 transistors and

other circuit elements with their associated circuits on a single chip made it possible to have microcomputers of fourth generation.

Fourth generation computers became more powerful, compact, reliable, and affordable. As a result, it gave rise to Personal Computer (PC) revolution. In this generation, time sharing, real time networks, distributed operating system were used. All the high-level languages like C, C++, DBASE etc., were used in this generation.



The main features of fourth generation are:

- VLSI technology used
- Very cheap
- Portable and reliable
- Use of PCs
- Very small size
- Pipeline processing
- No AC required
- Concept of internet was introduced
- Great developments in the fields of networks
- Computers became easily available

Some computers of this generation were:

- DEC 10

- STAR 1000
- PDP 11
- CRAY-1(Super Computer)
- CRAY-X-MP(Super Computer)

Fifth Generation Computers

The period of fifth generation is 1980-till date. In the fifth generation, VLSI technology became ULSI (Ultra Large Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components.

This generation is based on parallel processing hardware and AI (Artificial Intelligence) software. AI is an emerging branch in computer science, which interprets the means and method of making computers think like human beings. All the high-level languages like C and C++, Java, .Net etc., are used in this generation.



AI includes:

- Robotics
- Neural Networks
- Game Playing
- Development of expert systems to make decisions in real-life situations
- Natural language understanding and generation

The main features of fifth generation are:

- ULSI technology
- Development of true artificial intelligence
- Development of Natural language processing
- Advancement in Parallel Processing
- Advancement in Superconductor technology
- More user-friendly interfaces with multimedia features
- Availability of very powerful and compact computers at cheaper rates

Some computer types of this generation are:

- Desktop
- Laptop
- NoteBook
- UltraBook
- ChromeBook

4. Computer Fundamentals – Types

Computers can be broadly classified by their speed and computing power.

Sr. No.	Type	Specifications
1	PC (Personal Computer)	It is a single user computer system having moderately powerful microprocessor
2	Workstation	It is also a single user computer system, similar to personal computer however has a more powerful microprocessor
3	Mini Computer	It is a multi-user computer system, capable of supporting hundreds of users simultaneously.
4	Main Frame	It is a multi-user computer system, capable of supporting hundreds of users simultaneously. Software technology is different from minicomputer.
5	Supercomputer	It is an extremely fast computer, which can execute hundreds of millions of instructions per second.

PC (Personal Computer)

A PC can be defined as a small, relatively inexpensive computer designed for an individual user. PCs are based on the microprocessor technology that enables manufacturers to put an entire CPU on one chip. Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications. At home, the most popular use for personal computers is playing games and surfing the Internet.

Although personal computers are designed as single-user systems, these systems are normally linked together to form a network. In terms of power, now-a-days high-end models of the Macintosh and PC offer the same computing power and graphics capability as low-end workstations by Sun Microsystems, Hewlett-Packard, and Dell.



Workstation

Workstation is a computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other such types of applications which require a moderate amount of computing power and relatively high quality graphics capabilities.

Workstations generally come with a large, high-resolution graphics screen, large amount of RAM, inbuilt network support, and a graphical user interface. Most workstations also have mass storage device such as a disk drive, but a special type of workstation, called diskless workstation, comes without a disk drive.

Common operating systems for workstations are UNIX and Windows NT. Like PC, workstations are also single-user computers like PC but are typically linked together to form a local-area network, although they can also be used as stand-alone systems.



Minicomputer

It is a midsize multi-processing system capable of supporting up to 250 users simultaneously.



Mainframe

Mainframe is very large in size and is an expensive computer capable of supporting hundreds or even thousands of users simultaneously. Mainframe executes many programs concurrently and supports many simultaneous execution of programs.



Supercomputer

Supercomputers are one of the fastest computers currently available. Supercomputers are very expensive and are employed for specialized applications that require immense amount of mathematical calculations (number crunching).

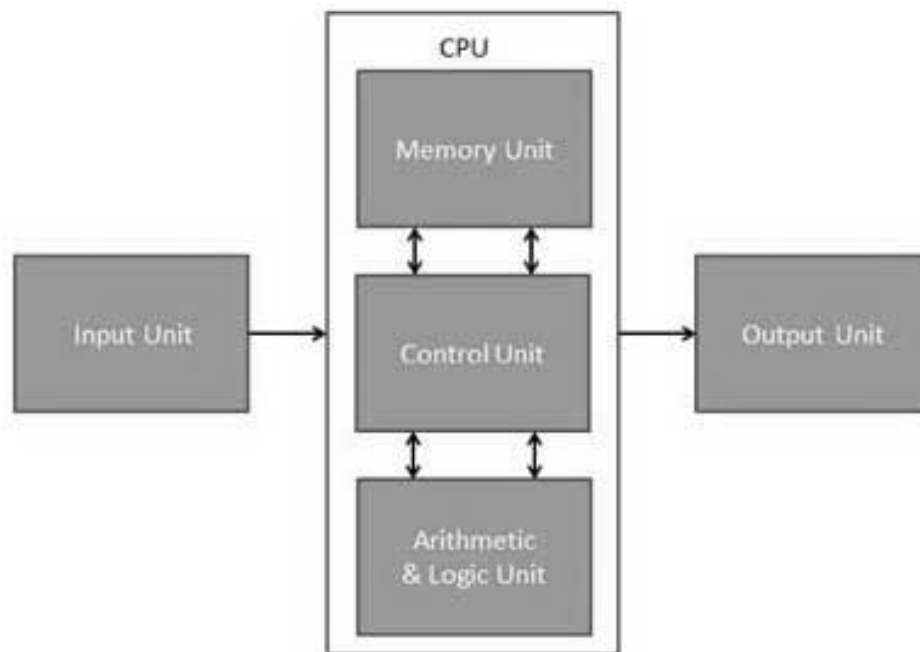


For example, weather forecasting, scientific simulations, (animated) graphics, fluid dynamic calculations, nuclear energy research, electronic design, and analysis of geological data (e.g. in petrochemical prospecting).

5. Computer Fundamentals – Components

All types of computers follow the same basic logical structure and perform the following five basic operations for converting raw input data into information useful to their users.

Sr. No.	Operation	Description
1	Take Input	The process of entering data and instructions into the computer system.
2	Store Data	Saving data and instructions so that they are available for processing as and when required.
3	Processing Data	Performing arithmetic, and logical operations on data in order to convert them into useful information.
4	Output Information	The process of producing useful information or results for the user, such as a printed report or visual display.
5	Control the workflow	Directs the manner and sequence in which all of the above operations are performed.



Input Unit

This unit contains devices with the help of which we enter data into the computer. This unit creates a link between the user and the computer. The input devices translate the information into a form understandable by the computer.

CPU (Central Processing Unit)

CPU is considered as the brain of the computer. CPU performs all types of data processing operations. It stores data, intermediate results, and instructions (program). It controls the operation of all parts of the computer.

CPU itself has the following three components:

- ALU (Arithmetic Logic Unit)
- Memory Unit
- Control Unit

Output Unit

The output unit consists of devices with the help of which we get the information from the computer. This unit is a link between the computer and the users. Output devices translate the computer's output into a form understandable by the users.

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