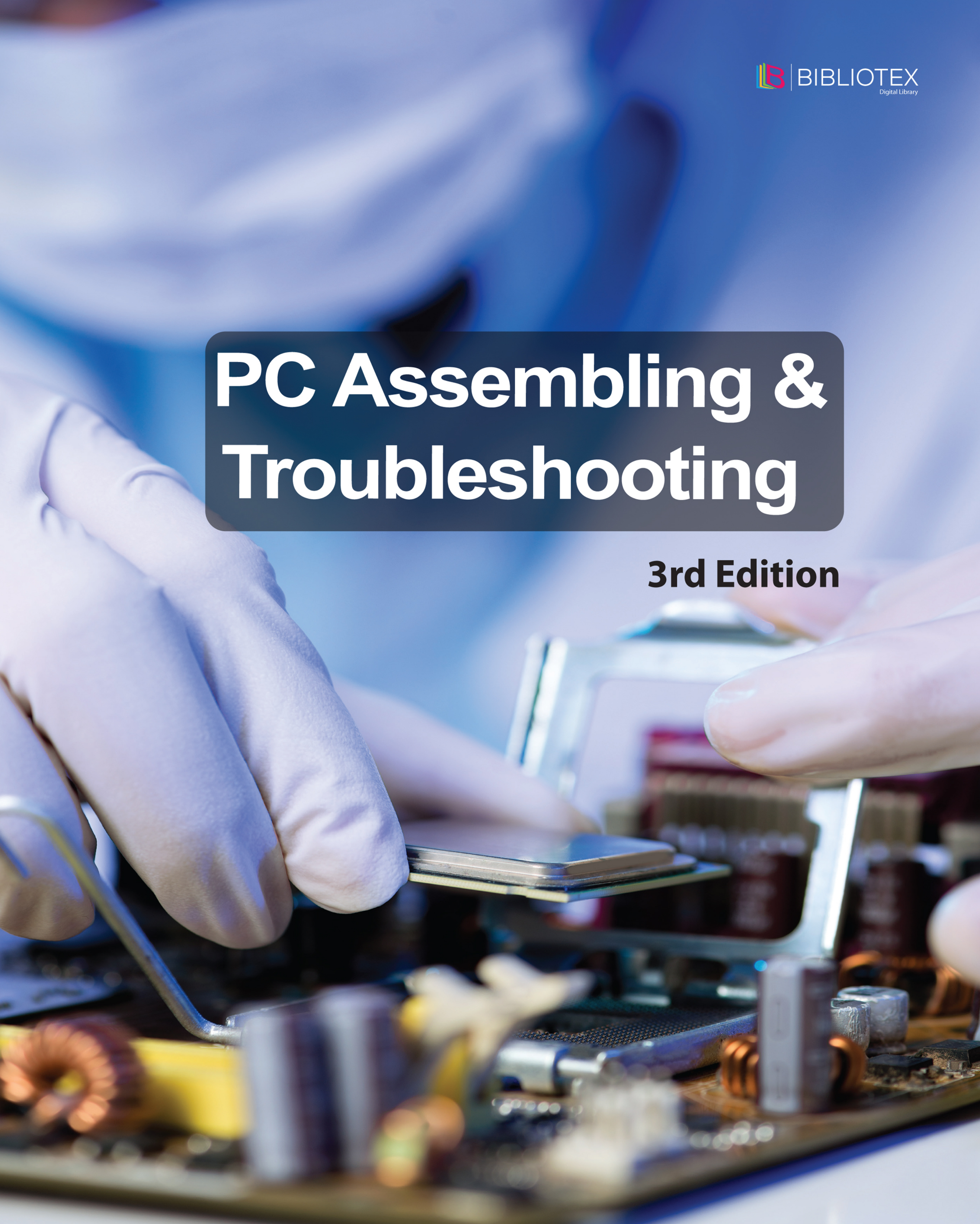

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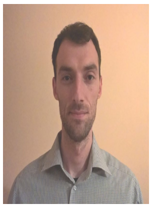
EDITORIAL BOARD

Fozia Parveen has a Dphil in Sustainable Water Engineering from the University of Oxford. Prior to this she has received MS in Environmental Sciences from National University of Science and Technology (NUST), Islamabad Pakistan and BS in Environmental Sciences from Fatima Jinnah Women University (FJWU), Rawalpindi.



Igor Krunic 2003-2007 in the School of Economics. After graduating in 2007, he went on to study at The College of Tourism, at the University of Belgrade where he got his bachelor degree in 2010. He was active as a third-year student representative in the student parliament.Then he went on the Faculty of science, at the University of Novi Sad where he successfully defended his master's thesis in 2013. The crown of his study was the work titled Opportunities for development of cultural tourism in Cacak". Later on, he became part of a multinational company where he got promoted to a deputy director of logistic. Nowadays he is a consultant and writer of academic subjects in the field of tourism.

Dr. Jovan Pehcevski obtained his PhD in Computer Science from RMIT University in Melbourne, Australia in 2007. His research interests include big data, business intelligence and predictive analytics, data and information science, information retrieval, XML, web services and service-oriented architectures, and relational and NoSQL database systems. He has published over 30 journal and conference papers and he also serves as a journal and conference reviewer. He is currently working as a Dean and Associate Professor at European University in Skopje, Macedonia.

Dr. Tanjina Nur finished her PhD in Civil and Environmental Engineering in 2014 from University of Technology Sydney (UTS). Now she is working as Post-Doctoral Researcher in the Centre for Technology in Water and Wastewater (CTWW) and published about eight International journal papers with 80 citations. Her research interest is wastewater treatment technology using adsorption process.

Stephen obtained his PhD from the University of North Carolina at Charlotte in 2013 where his graduate research focused on cancer immunology and the tumor microenvironment. He received postdoctoral training in regenerative and translational medicine, specifically gastrointestinal tissue engineering, at the Wake Forest Institute of Regenerative Medicine. Currently, Stephen is an instructor for anatomy and physiology and biology at Forsyth Technical Community College.

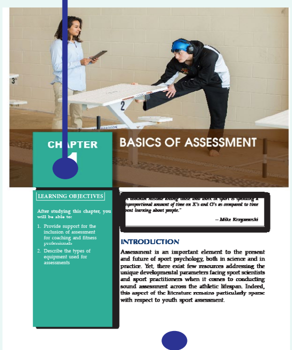
Michelle holds a Masters of Business Administration from the University of Phoenix, with a concentration in Human Resources Management. She is a professional author and has had numerous articles published in the Henry County Times and has written and revised several employee handbooks for various YMCA organizations throughout the United States.

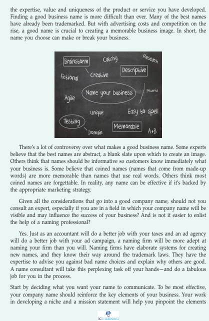
HOW TO USE THE BOOK

This book has been divided into many chapters. Chapter gives the motivation for this book and the use of templates. The text is presented in the simplest language. Each paragraph has been arranged under a suitable heading for easy retention of concept. Keywords are the words that academics use to reveal the internal structure of an author's reasoning. Review questions at the end of each chapter ask students to review or explain the concepts. References provides the reader an additional source through which he/she can obtain more information regarding the topic.

LEARNING OBJECTIVES

See what you are going to cover and what you should already know at the start of each chapter



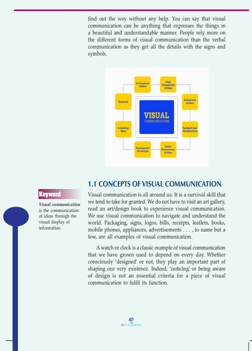


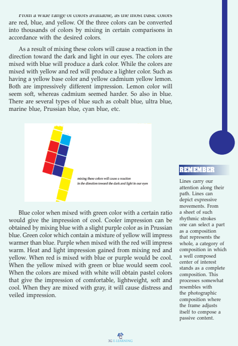
ABOUT THIS CHAPTER

An introduction is a beginning of section which states the purpose and goals of the topics which are discussed in the chapter. It also starts the topics in brief.

REMEMBER

This revitalizes a must read information of the topic.





KEYWORDS

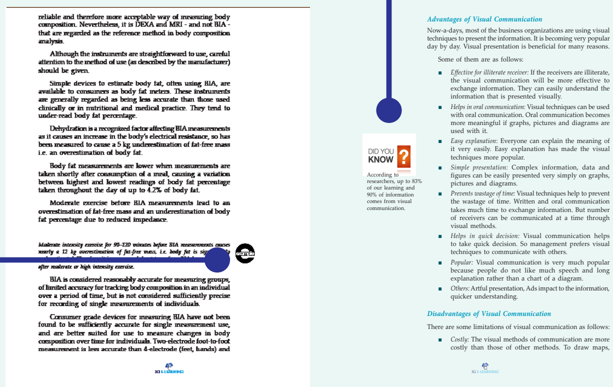
This section contains some important definitions that are discussed in the chapter. A keyword is an index entry that identifies a specific record or document. It also gives the extra information to the reader and an easy way to remember the word definition.

DID YOU KNOW?

This section equip readers the interesting facts and figures of the topic.

EXAMPLE

The book cabinets' examples to illustrate specific ideas in each chapter.

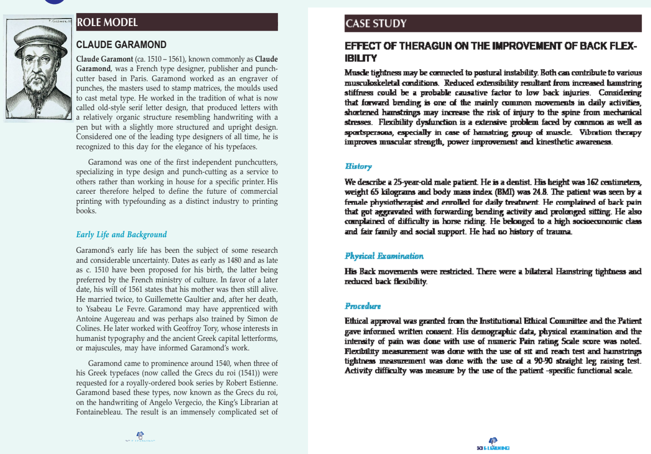


ROLE MODEL

A biography of someone who has/had acquired remarkable success in their respective field as Role Models are important because they give us the ability to imagine our future selves.

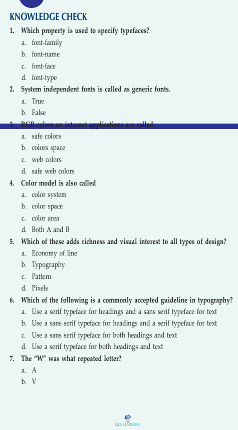
CASE STUDY

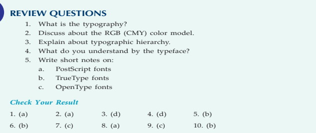
This reveals what students need to create and provide an opportunity for the development of key skills such as communication, group working and problem solving.



KNOWLEDGE CHECK

This is given to the students for progress check at the end of each chapter.





REVIEW QUESTIONS

This section is to analyze the knowledge and ability of the reader.

REFERENCES

References refer those books which discuss the topics given in the chapters in almost same manner.

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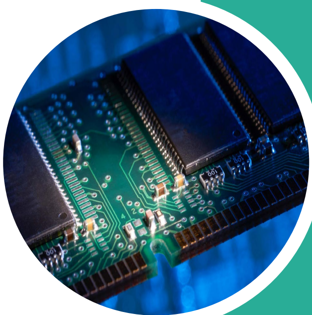


PREFACE

Personal computers have become an important part of society with people depending on them for activities from business to entertainment or education. Access to technology, especially to personal computers (PCs), has shifted from privilege to necessity in many parts of the world. In the current world, it's almost impossible to imagine that someone can live without computers. They have become an electronic device of almost every day use for individuals of every age, and essential in almost all the business dealings that are made nowadays. The most that any industry has gained from the discovery of the computer is the business industry because of its nature. In recent years they have gained significance as they have improved the efficiency and productivity of work done. Large amounts of information in industrial and business sectors as well as in the personal lives are stored on servers.

Organization of the Book

As laid out in the Table of Contents, this edition of PC Assembling & Troubleshooting presents the coverage in eleven chapters. This book is the unrivaled source for students and professionals who work in PC assembling --whether the applications are commercial, industrial, or consumer

Chapter 1 provides a detailed description on all major components of a PC, such as input devices, output devices, a system unit, storage devices, communications devices, and motherboard and BIOS.

Chapter 2 focuses on basics of software and hardware, their types, and integrated development environment.

Chapter 3 illustrates the identifying, installing and troubleshooting floppy drives. It also reveals installing an optical drive guide and CD media.

Chapter 4 presents the procedure of installing a hard drive and the formatting and partitioning a hard drive. Also basic troubleshooting techniques are explored.

Chapter 5 delivers the troubleshooting of monitor and video card problems.

Chapter 6 covers the basic principles of troubleshooting input devices. Since the job of a computer is primarily to process input, computers are pretty useless without input devices.

Chapter 7 explains the procedure of installing a printer on windows pc, basic printer maintenance, and the recognizing and fixing basic printing problems.

Chapter 8 presents the coverage of factors in power supplies and computer cooling system solutions.

Chapter 9 presents a focus on internetworking system. It discusses about the fundamental and principles of internetworking. It also examine the IP addressing and architecture.

Chapter 10 sheds light on workflow of microprocessor. It also explain the application of microprocessors.

Chapter 11 is computer memory management. Memory management is the process of controlling and coordinating computer memory, assigning portions called blocks to various running programs to optimize overall system performance.

CHAPTER 1
COMPONENTS OF A PC

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Explain the major components of a PC
2. Discuss about the central processing unit (CPU)
3. Define the random access memory (RAM)
4. Explain the motherboard and BIOS
5. Describe the term expansion bus

"Computers are magnificent tools for the realization of our dreams, but no machine can replace the human spark of spirit, compassion, love, and understanding."

—Louis V. Gerstner, Jr.

INTRODUCTION

Computer components like the CPU, motherboard, computer case, RAM and drive are the core of a computer. They determine the capabilities and features of a computer, as well as its power and processing speeds. It's important to choose computer components that can work together to satisfy your needs.

When building a PC, it's finding the best PC components that will really test your patience and endurance. That's especially with so many options to choose from and manufacturers rolling out new ones every few months. In fact, the act of building a PC itself may be the easier part of the process.

Choosing the ideal graphics card, processor, motherboard or even RAM, therefore, to match your needs and budget is never going to be a walk in the park. But, we're here to help – perhaps even help you score an amazing deal.

Having a good idea of what you want can make your PC building experience so much better. And, with this guide, we can help you get your planning and research started, and find the best PC components at a reasonable price. It'll help set you on the right path to choosing the best PC components. This way, you can get your rig up and running without the added stress.

Keyword

Input Device: It is a peripheral used to provide data and control signals to an information processing system such as a computer or other information appliance.

1.1 IDENTIFYING THE MAJOR COMPONENTS OF A PC

Different types of **input devices** are designed to transmit different types of data or to transmit data in different ways. Think of other input devices (joysticks, scanners, digital cameras, and so on) and the different types of data they transmit or the different ways they transmit data. Because it is more lasting than output from a monitor or speaker, the printer's output often is called hard copy.

Some computer components are considered internal, while others are considered external. External components are called peripherals. Input, output, and communications devices often are peripheral devices. The difference between the temporary character of memory and permanent nature of storage will be made painfully clear the first time you experience a power failure while working on a computer. Think of other examples of storage devices (magnetic tape, PC Cards, and so on). The capability to communicate may be one of the most significant factors influencing how computers are used now and in the future.

1.1.1 System Unit

A computer system unit is the enclosure that contains the main components of a computer. It is also referred to as computer case or tower. A typical desktop computer consists of a computer system unit, a keyboard, a mouse, and a monitor. The computer system unit is the enclosure for all the other main interior components of a computer. It is also called the computer case, computer chassis, or computer tower. Cases are typically made of steel or aluminum, but plastic can also be used. While most computer cases are rather dull, black, metal boxes, some manufacturers try to give the unit some flair with color and special design elements.

Functions

The primary function of the computer system unit is to hold all the other components together and protect the sensitive electronic parts from the outside elements. A typical computer case is also large enough to allow for upgrades, such as adding a second hard drive or a higher-quality video card. It is relatively easy to open up a computer system unit to replace parts and install upgrades. In contrast, it is quite difficult to open up a laptop computer, which is not designed with replacements and upgrades in mind.

In most computer system units, the front side contains the elements a user needs frequently, such as the power button, an optical disk drive, an audio outlet for a pair of headphones, and a number of USB connections. The back side contains all other connections - for power, monitor, keyboard, mouse, Internet connection, and any other peripheral devices. There are typically more connections than the minimum necessary to allow for expansion.

1.1.2 Monitors

The monitor is the piece of computer hardware that displays the video and graphics information generated by the computer through the video card. Monitors are very similar to televisions but usually display information at a much higher resolution. The term "monitor" is often used synonymously with "computer screen" or "display." The monitor displays the computer's user interface and open programs, allowing the user to interact with the computer, typically using the keyboard and mouse.

Older computer monitors were built using cathode ray tubes (CRTs), which made them rather heavy and caused them to take up a lot of desk space. Most modern monitors are built using LCD technology and are commonly referred to as flat screen displays. These thin monitors take up much less space than the older CRT displays. This means people with LCD monitors have more desk space to clutter up with stacks of papers, pens, and other objects.

"Monitor" can also be used as a verb. A network administrator may monitor network traffic, which means he watches the traffic to make sure the bandwidth usage is within a certain limit and checks to what external sources may be attempting to access the network. Software programs may monitor the system's CPU performance as well as RAM and hard disk usage.

Finally, monitors also refer to speakers used for monitoring sound. Audio engineers typically use "studio monitors" to listen to recordings. These high-end speakers allow the engineers to accurately mix and master audio tracks. So a sound mixer could be monitoring a recording visually using a computer monitor, while monitoring the sound using audio monitors at the same. As we can tell, "monitor" serves as a rather multipurpose word.

Different Types of Monitors

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

- CRT (Cathode Ray Tube)
- LCD (Liquid Crystal Display)
- LED (Light-Emitting Diodes)

CRT (Cathode Ray Tube) Monitors

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

LCD (Liquid Crystal Display) Monitors

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

LED (Light-Emitting Diodes) Monitors

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

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

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

1.1.3 Keyboard

The **keyboard** is the piece of computer hardware used to input text, characters and other commands into a computer or similar device. Keyboard is basically a board of keys. Along with the mouse, the keyboard is one of the primary input devices used with a computer. The keyboard's design comes from the original typewriter keyboards, which arranged letters and numbers in a way that prevented the type-bars from getting jammed when typing quickly. This keyboard layout is known as the QWERTY design, which gets its name from the first six letters across in the upper-left-hand corner of the keyboard. While the design of computer keyboards may have come from typewriters, today's keyboards have many other keys as well. Modifier keys, such as Control, Alt/Option, and Command (Mac) or the Windows key (Windows) can be used in conjunction with other keys as "shortcuts" to perform certain operations.

Keyword

Keyboard: It is the set of typewriter-like keys that enables you to enter data into a computer.

For example, pressing Command-S (Mac), or Control-S (Windows) typically saves a document or project you are working on. Most of today's computer keyboards also have a row of function keys (F1 through F16) along the top of the keyboard, arrow keys arranged in an upside-down T, and a numeric keypad on the right-hand side. Some keyboards have even more buttons, allowing you to change the system volume, eject a CD, or open programs such as the e-mail or Web browser. The computer keyboard uses the same key arrangement as the mechanical and electronic typewriter keyboards that preceded the computer. The standard arrangement of alphabetic keys is known as the QWERTY (pronounced KWEHR-tee) keyboard, its name deriving from the arrangement of the five keys at the upper left of the three rows of alphabetic keys. This arrangement, invented for one of the earliest mechanical typewriters, dates back to the 1870s. Another well-known key arrangement is the Dvorak system, which was designed to be easier to learn and use. The Dvorak keyboard was designed with the most common consonants on one side of the middle or home row and the vowels on the other side so that typing tends to alternate key strokes back and forth between hands. Although the Dvorak keyboard has never been widely used, it has adherents.

1.1.4 Mouse Devices

A mouse is a small device that a computer user pushes across a desk surface in order to point to a place on a display screen and to select one or more actions to take from that position. A mouse is a small device that a computer user pushes across a desk surface in order to point to a place on a display screen and to select one or more actions to take from that position. The mouse first became a widely-used computer tool when Apple Computer made it a standard part of the Apple Macintosh. Today, the mouse is an integral part of the graphical user interface (GUI) of any personal computer. The mouse apparently got its name by being about the same size and color as a toy mouse. A mouse consists of a metal or plastic housing or casing, a ball that sticks out of the bottom of the casing and is rolled on a flat surface, one or more buttons on the top of the casing, and a cable that connects the mouse to the computer. As the ball is moved over the surface in any direction, a sensor sends impulses to the computer that causes a mouse-responsive program to reposition a visible indicator (called a cursor) on the display screen. The positioning is relative to some variable starting place. Viewing the cursor's present position, the user readjusts the position by moving the mouse.

When viewing a Web page, you can click on an image to get a popup menu that, among other things, lets you save the image on the hard disk. Some mouse has a third button for additional capabilities. Some mouse manufacturers also provide a version for left-handed people.

example

The most conventional kind of mouse has two buttons on top: the left one is used most frequently. In the Windows operating systems, it lets the user click once to send a "Select" indication that provides the user with feedback that a particular position has been selected for further action. The next click on a selected position or two quick clicks on it causes a particular action to take place on the selected object. For example, in Windows operating systems, it causes a program associated with that object to be started. The second button, on the right, usually provides some less-frequently needed capability.

Types of Mouse

Mouse button have been making computing tasks easier for many years. Over time, mouse has already been specifically manufactured to simplify certain tasks. Optical mouse offer more fluid movement, and a lot of them are wireless. Ergonomic mouse are already designed to help arthritis and CTS sufferers. Together with the various mouse available, you can search for a mouse designed for the requirements. Websites including Quill and OfficeMax give you a various personal computer mouse from which to choose, including:

Traditional Mouse

Traditional computer mouse button will be the most affordable, when they make use of a simple construction. They connect to the personal machine utilizing the mouse port, and some mouse for Apple computers use a USB connection. The mouse includes a USB connection for those who love the USB port within the mouse port.

No special application is needed, while you need to reboot after connecting in case you are employing an older version of Windows. This kind of mouse does need to be periodically disassembled for cleaning. One should make use of a lint-free, static-free cloth for cleaning. It will eliminate harm to mouse preventing any bothersome lint buildup.

Optical Mouse

Optical mouse have become more commonplace. They exercise efficiently, because they lack the ball found in traditional mouse. The majority are built to be ergonomic, so we are able to make use of them very comfortably. The mouse is less vulnerable to collecting dust than traditional mouse are and require less cleaning. Most optical mouse hook up to computer through the USB port. Special software usually is not necessary if one do not need advanced functions enabled for the mouse. One is able to enable any special functions that we want mouse to accomplish when using the driver CD that had the mouse.

Wireless Mouse

Wireless mouse provide capability of connecting without cables. That is very useful for gamers as well as others who want room to freely move their mouse. A button talks to the computer with the infrared port that you just attach yourself. Some newer laptops consist of built-in infrared ports where we can start employing the mouse without special hardware.

These sorts of mouse include the necessary driver software. We will normally be capable to start using the brand-new mouse during first minutes. Wireless mouse are optical, taking into account easier movement. Wireless mouse is purchased plus a wireless keyboard. When we have got a large enough monitor, we are able to safely sit well back through the computer and still have the capacity to apply it efficiently.

Laptop Mouse

Laptop mouse have numerous of identical features as desktop mouse. They give a more compact design that is well-suited to smaller spaces that laptops are utilized in. The mouse is ideal for laptop users unaccustomed to track-pads. Additionally they are useful if the track-pad fails and you possess zero chance to change it instantly. Laptop mouse use a retractable cord having a USB connection or may include wireless connection.

DID YOU KNOW ?

The first two optical mice, first demonstrated by two independent inventors in December 1980, had different basic designs:One of these, invented by Steve Kirsch of MIT and Mouse Systems Corporation, used an infrared LED and a four-quadrant infrared sensor to detect grid lines printed with infrared absorbing ink on a special metallic surface.

1.1.5 Identifying the Internal Components of a PC

Power Supply

The first component is power supply. It converts AC power from the wall into DC power that can be used by the components in the PC system.

Motherboard

The motherboard contains all of the wiring that is necessary for the different devices to communicate with each other. It can also be called main-board or planar.

CPU

The next component is the CPU or processor, the brain of the computer system. This will be the primary factor in how fast the system is. CPUs get really hot so to keep them cool, we use a fan and heat-sink to dissipate the heat.

RAM

The next component is the memory. The memory is where the CPU stores the applications and data that it is currently working on.

Video Card

Unless the motherboard comes with a built-in video card, we will have to install a separate video card into the computer system. Graphic or video cards are typically needed to deal with PC gaming, high definition video and multiple displays.

Sound Card

Sound cards enable the computer to output, record and manipulate sound. Now it is common to have a built in sound card on motherboards, when talking about personal computers.

Expansion Slots

The next components are the expansion slots. PCs are customizable and they are modular. If we want our PC to perform some additional function, we can add expansion board and install it in one of these expansion slots.

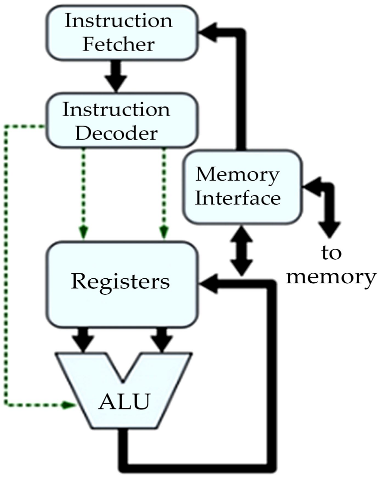
Storage

The next components are long-term storage mediums. The problem with RAM or memory is that it is not persistent. When we shut down our system the contents of RAM is lost. To save data long term, we have to have long-term storage devices. Hard drives stores data magnetically on a spinning disk. It can be written to or it can be read from.

1.2 THE CENTRAL PROCESSING UNIT (CPU)

The **central processing unit** (CPU) is the component that performs all calculations and mathematical manipulations in a computer. CPUs are sometimes single-chip devices and sometimes are packaged together with supporting circuits like memory and buffers mounted on a board, and packaged together in a single unit.

The Central Processing Unit (CPU; sometimes just called processor) is a machine that can execute computer programs. It is sometimes referred to as the brain of the computer.



There are four steps that nearly all CPUs use in their operation: fetch, decode, execute, and write back. The first step, fetch, involves retrieving an instruction from program memory. In the decode step, the instruction is broken up into parts that have significance to other portions of the CPU. During the execute step various portions of the CPU, such as the arithmetic logic unit (ALU) and the floating point unit (FPU) are connected so they can perform the desired operation. The final step, write back, simply writes back the results of the execute step to some form of memory.

1.2.1 Identifying the Right CPU for any Motherboard

If you are deciding what parts will work best in the computer, it is best to note the importance of finding the right CPU, or central processing unit, to complement the motherboard. Motherboards offer various "socket types" that only work with processors that match the required socket. These socket types vary based on the CPU manufacturer. *For example*, an Intel socket type will not work with an AMD processor, and vice versa.

Keyword

Central Processing Unit (CPU): It is the hardware within a computer that carries out the instructions of a computer program by performing the basic arithmetical, logical, control, and input/output operations of the system.

Instructions for identifying the right CPU for any motherboard are as following:

- Determine the motherboard's socket type. This information is printed in the motherboard's manual. If you do not have the manual, you can also visit the manufacturer's website to find this information based on the motherboard's model name.
- Determine the CPU's socket type. This information can once again be found on the manufacturer's website or on the packaging for the CPU. An example would be an LGA-1156 CPU socket type which can be used with an LGA-1156 CPU compatible processor such as the Intel i7-860.
- Find a CPU that offers compatible FSB speeds with the motherboard. FSB refers to front side bus. *For example* a motherboard that supports up to 800MHz will not work with a CPU running at 1066MHz. However you can install a slower FSB CPU on a faster front side bus motherboard; you simply will not receive the faster FSB speeds.
- Use the Intel chipset finder to determine what chipsets are available and what type of processors are available for Intel processors. This process works best if you have not yet chosen the motherboard and would like to find a compatible socket type. AMD users can visit the AMD processor search page and on the left side choose the required socket type from the drop-down menu.
- Check in the motherboard's manual or on the motherboard's website for a list of compatible CPUs. Many motherboards will provide information about compatible Intel processors or AMD processors (on AMD motherboards).

1.2.2 CPU Manufacturers

When it comes to choosing a machine for you, the criteria of considering a CPU satisfactory differs from person to person. However, according to the stats that have been collected by targeting a huge audience declare the following CPU manufacturers:

- Intel
- AMD
- IBM
- NVIDIA
- Motorola
- Conner Langan
- Sun
- Qualcomm
- Via
- TI

1.2.3 CPU Speeds

"CPU speed" was once an easy, if not completely accurate, way to compare two computers' performance just compare the GHz.

Once upon a time, a processor's clock speed might have been the most reliable indicator of performance, but these days, it is just one of many important factors to consider. It is only meaningful, in fact, when compared to other CPUs in the same series; a quad-core 2.5GHz Core 2 Quad Q9400 from Intel will trounce a 3GHz Core 2 Duo E8400 in many tasks, for example. Those multiple processing cores are more important than the 500MHz difference in clock speed.

Another important factor is a processor's L2 cache, which stores memory data and speeds up operation by making recently accessed data immediately available to the processor. Generally, the larger the L2 cache, the bigger the performance increase you can expect, at least with Intel CPUs that utilize one larger shared cache. AMD processors, on the other hand, give each core its own cache.

Modern CPUs are more than fast enough for most basic tasks, so you shall also want to look at other things when it comes to comparing performance.

Does the computer come with an SSD or a slower magnetic hard disk? CPU clock speed, or clock rate, is measured in Hertz generally in gigahertz, or GHz. A CPU's clock speed rate is a measure of how many clock cycles a CPU can perform per second.

For example, a CPU with a clock rate of 1.8 GHz can perform 1,800,000,000 clock cycles per second.

The Core i7 CPU can simply do much more during each clock cycle. It is important to look not just at clock cycles but at the amount of work a CPU can do per clock cycle. All other things being equal, fewer clock cycles with more work are better than more clock cycles with less fewer clock cycles means the CPU requires less power and produces less heat.

1.2.4 Installing and Upgrading CPUs

Installation Procedure

Make sure that the motherboard supports the CPU before installation. We assume that you are installing the CPU onto the motherboard before installing the motherboard into the system case, and it is highly recommended that installations be approached this way.

Locate the CPU Socket

Locate the CPU socket on the motherboard.

Open the CPU Socket

Gently lift the CPU socket lever to the upright position to open the socket. For the LGA775 socket, you need to pull the CPU socket plate up after lifting the lever.

Align the Processor

Locate the diagonal corner (golden triangle) on the upwards facing side of the processor. Align the processor so that this corner matches on the processor and the socket. This step may vary with different socket types, please refer to the processor, motherboard and heat-sink (CPU cooler) manuals for detailed instructions.

Insert the Processor

Carefully place the CPU into the socket in a straight and downwards motion.

Lock the Processor

Push the lever back into its original position to lock the processor. You need to close the CPU socket plate before engaging the lever on the LGA775 platform.

Apply Thermal Paste

Apply an even layer of thermal paste on the surface of the installed processor. It is highly recommended that you use a plastic card to spread the thermal paste evenly, or use the finger with a new and clean plastic bag over it instead. This prevents contamination of the thermal paste. This procedure may not be necessary when using a heat sink with thermal paste already applied to its base.

Align the Heat-sink

Place the heat-sink atop the processor; align the heat-sink so that its clamps/clips are in line with the mounting holes on the motherboard. Please refer to the heat-sink/cooler manual for precise instructions.

Mount the Heats-ink

Clamp/Mount the heat-sink in place using the proper technique. Be careful at this step since the motherboard and/or the CPU will be under a lot of pressure, and the screwdriver (which may not be necessary) can cause serious damage to the motherboard in the case of a slip.

Attach the Heat-sink fan Header

Finally, attach the heat-sink power connector to the CPU fan header located on the motherboard and make sure it is properly plugged in.

1.2.5 Replacing Heat-sink and Fan Assembly

The heat sink might be very hot. Turn off the computer and wait three to five minutes to let the computer cool before opening the computer cover.

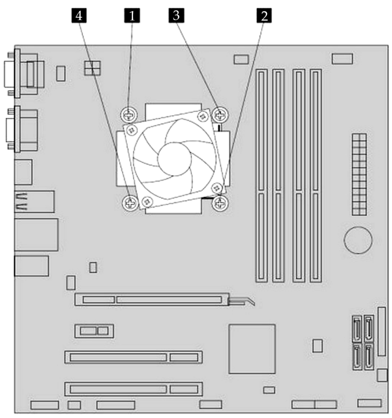
To replace the heat sink and fan assembly, do the following:

- Turn off the computer and disconnect all power cords from electrical outlets.
- Remove the computer cover. See "Removing the computer cover".
- Lay the computer on its side for easier access to the system board.
- Locate the heat sink and fan assembly. See "Locating parts on the system board".
- Disconnect the heat sink and fan assembly cable from the **microprocessor** fan connector on the system board. See "Locating parts on the system board".

Keyword

Microprocessor is a computer processor wherein the data processing logic and control is included on a single integrated circuit, or a small number of integrated circuits.

- Follow this sequence to remove the four screws that secure the heat sink and fan assembly to the system board:
- Partially remove screw 1, then fully remove screw 2, and then fully remove screw 1.
- Partially remove screw 3, then fully remove screw 4, and then fully remove screw 3.
- Lift the failing heat sink and fan assembly off the system board.
  - You might have to gently twist the heat sink and fan assembly to free it from the microprocessor.
  - Do not touch the thermal grease while handling the heat sink and fan assembly.
- Position the new heat sink and fan assembly on the system board so that the four screws are aligned with the holes on the system board.
  - Position the new heat sink and fan assembly so that the heat sink and fan assembly cable is toward the microprocessor fan connector on the system board.



- Follow the following sequence to install the four screws to secure the new heat sink and fan assembly. Do not over-tighten the screws.
  - Partially tighten screw 1, then fully tighten screw 2, and then fully tighten screw 1.
  - Partially tighten screw 3, then fully tighten screw 4, and then fully tighten screw 3.
- Connect the heat sink and fan assembly cable to the microprocessor fan connector on the system board. See "Locating parts on the system board".
- To complete the installation or replacement, go to "Completing the parts replacement".

1.3 RANDOM ACCESS MEMORY (RAM)

Random-access memory is a form of computer data storage. A random-access memory device allows data items to be read and written in roughly the same amount of time regardless of the order in which data items are accessed.

RAM is a computer storage location that allows information to be stored and accessed quickly from random locations within DRAM on a memory module. Because information is accessed randomly instead of sequentially like a CD or hard drive the computer can access the data much faster than it would if it was only reading the hard drive. However, unlike ROM and the hard drive RAM is a volatile memory and requires power in order to keep the data accessible, if power is lost all data contained in memory lost.

As the computer loads parts of the operating system and drivers are loaded into memory, which allows the CPU to process the instructions much faster and the computer to load faster. After the operating system has loaded, each program you open such as the browser you are using to view this page is loaded into memory while it is running. If too many programs are open the computer will swap the data in the memory between the RAM and the hard disk drive.

Over the evolution of computers there have been different variations of RAM used in computer. Some of the more common examples are DIMM, RIMM, SIMM, SO-DIMM, and SOO-RIMM.

1.3.1 Types of RAM

At the time of writing, there are several types of RAM, which are quite different. This means that they normally cannot be used on the same motherboard they are not compatible. However, some motherboards can have sockets for two types of RAM. You typically see this during periods where there is a change taking place from one type of RAM to another. Such motherboards are really designed for the new type, but are made “backwards compatible”, by making room for RAM modules of the old type. The RAM types on the market at the moment are presented in the Table.

RAM Type	Pins	Width	Usage
SD RAM	168	64 bit	Older and slower type. No use.
Rambus RAM	184	16 bit	Advanced RAM. Only used for very few Pentium 4's with certain Intel chipsets.
DDR RAM	184	64 bit	A faster version of SD RAM. Used both for Athlon and Pentium 4's. 2, 5 Volt.
DDR2 RAM	240	64 bit	New version of DDR RAM with higher clock frequencies. 1, 8 Volt.

There is a lot of development taking place in DDR. A number of new RAM products will be released within the next few years. The modules are packaged differently, so they cannot be mixed. The notches in the sides are different as the bottom edges of the modules are.

SDRAM is an old and proven type, which is used in the majority of existing PC's. DDR RAM is a refinement of SDRAM, which is in reality double clocked. Rambus RAM is an advanced technology which in principle is superior to DDR RAM in many ways. However, Rambus has had a difficult birth. The technology has been patented by Rambus Inc., which has been involved in many legal suits. A number of important manufacturers (such as VIA) have opted out of Rambus, and only develop products which use DDR RAM. With the new DDR2 standard, there is no obvious need for Rambus RAM.

Keyword

Inflammation is part of the complex biological response of body tissues to harmful stimuli, such as pathogens, damaged cells, or irritants, and is a protective response involving immune cells, blood vessels, and molecular mediators.

SDRAM (Synchronous DRAM)

Almost all systems used to ship with 3.3 volt, 168-pin SDRAM DIMMs. SDRAM is not an extension of older EDO DRAM but a new type of DRAM altogether. SDRAM started out running at 66 MHz, while older fast page mode DRAM and EDO max out at 50 MHz. SDRAM is able to scale to 133 MHz (PC133) officially, and unofficially up to 180MHz or higher. As processors get faster, new generations of memory such as DDR and RDRAM are required to get proper performance.

DDR (Double Data Rate SDRAM)

DDR basically doubles the rate of data transfer of standard SDRAM by transferring data on the up and down tick of a clock cycle. DDR memory operating at 333MHz actually operates at 166MHz * 2 (aka PC333 / PC2700) or 133MHz*2 (PC266 / PC2100).

DDR is a 2.5 volt technology that uses 184 pins in its DIMMs. It is incompatible with SDRAM physically, but uses a **similar parallel** bus, making it easier to implement than RDRAM, which is a different technology.

Rambus DRAM (RDRAM)

Despite it is higher price, Intel has given RDRAM it is blessing for the consumer market, and it will be the sole choice of memory for Intel's Pentium 4. RDRAM is a serial memory technology that arrived in three flavors, PC600, PC700, and PC800. PC800 RDRAM has doubled the maximum throughput of old PC100 SDRAM, but a higher latency. RDRAM designs with multiple channels, such as those in Pentium 4 motherboards, are currently at the top of the heap in memory throughput, especially when paired with PC1066 RDRAM memory.

REMEMBER

The SIMM was used with computers using a 486, early Intel Pentium, and compatible processors. However, because the Pentium is 64-bit and a SIMM is only 32-bits wide, they must be installed two at a time when used with any 64-bit processor. Today, the SIMM is rarely used and have been replaced by DIMMs.

1.3.2 RAM Packages

Memory package is a small circuit board that contains memory chips. Single In-line Memory Module (SIMM), Dual In-Line Memory Module (DIMM), Small Outline **Dual in-Line Memory** Module (SODIMM) and Micro DIMM are some of the memory packages. These packages are the form factors of a RAM chip. The installation of a memory depends on the form factors of a RAM. A form factor is the size and shape of the memory packages.

Keyword

Dual in-line memory module, commonly called a RAM stick, comprises a series of dynamic random-access memory integrated circuits. These modules are mounted on a printed circuit board and designed for use in personal computers, workstations, printers, and servers.

SIMM

Short for Single In-line Memory Module, SIMM is a memory module developed by Wang laboratories in 1983. The SIMM circuit board that holds six to nine memory chips per board, the ninth chip usually an error checking chip (parity or non-parity).

DIMM

Short for Dual In-line Memory Module, DIMM is a circuit board that holds memory chips. DIMMs have a 64-bit path because of the Pentium Processor requirements. Because of the new bit path, DIMMs can be installed one at a time, unlike SIMMs on a Pentium that would require two to be added. Below is an example image of a 512MB DIMM memory stick. SO-DIMM is short for Small Outline DIMM and is available as a 72-pin and 144-pin configuration. SO-DIMMs are commonly utilized in laptop computers.

Some of the advantages DIMMs have over SIMMs

- DIMMs have separate contacts on each side of the board, which provides twice as much data as a single SIMM.
- The command address and control signals are buffered on the DIMMs. With heavy memory requirements, this will reduce the loading effort of the memory.

RIMM

RIMM is not an acronym and is a trademark of Rambus incorporated for the Direct Rambus or DRAM (RDRAM) modules. RIMM is computer memory that resembles DIMMs; however, it is 184-pin and is available with built-in ECC support and Non-ECC at speeds up to 800MHz. RIMM modules are commonly used on the Intel Pentium 4 motherboards.

REMEMBER

Unlike most other computer memory, computers that support RIMM require a continuous signal. If a memory socket is left empty, the computer will not work properly. Therefore, users must utilize C-RIMM modules in any slots that do not have RIMM modules

1.3.2 Adding and Upgrading RAM

Upgrading the memory is the easiest way to modify the computer's speed. *For Example* a salesperson at a computer store what kind of memory you need for the computer. The individual memory sticks hold from 128 MB RAM up to 8 GB. Following are the steps to upgrade

- Get a new memory stick, then turn off the computer and the power supply and unplug the computer.
- Open up the computer by removing the screws in the back. (though some computers have a latch which is pushed)
- Locate the memory cards that are already in the computer. They are usually long and thin, and rectangular in shape.
- Touch the metal computer case with the hand in more than one place to discharge static electricity from the body. This static can damage the memory chips.

- Push the two white tabs down to release the current memory and pull out the chip.
- Line up the new chip and push it into place.
  - Make sure it is in the whole way. A clicking sound can usually be heard when the memory is secure.
- Turn the computer on.

1.4 MOTHERBOARD AND BIOS

A **motherboard** is one of the most essential parts of a computer system. It holds together many of the crucial components of a computer, including the central processing unit (CPU), memory and connectors for input and output devices. The base of a motherboard consists of a very firm sheet of non-conductive material, typically some sort of rigid plastic. Thin layers of copper or aluminum foil, referred to as traces, are printed onto this sheet. These traces are very narrow and form the circuits between the various components. In addition to circuits, a motherboard contains a number of sockets and slots to connect the other components.

Keyword

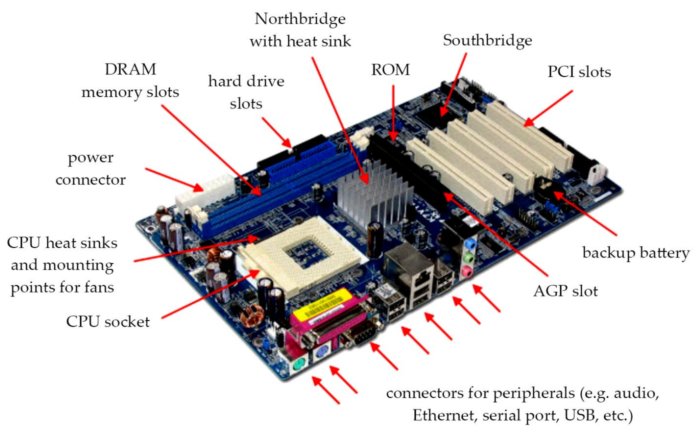
Motherboard: It is the main printed circuit board (PCB) found in computers and other expandable systems.

Parts of a Motherboard

If you were to open up the computer and take out the motherboard, you would probably get pretty confused about all the different parts. Depending on the make and model of the computer, it might look something like the Figure.

To understand how computers work you do not need to know every single part of the motherboard. However, it is good to know some of the most important parts and how the motherboard connects the various parts of a computer system together. Parts of Motherboards are as follows:

- *A CPU Socket:* The actual CPU is directly soldered onto this socket. Since high speed CPUs generates a lot of heat, there are heat sinks and mounting points for fans right next to the CPU socket.
- A power connector to distribute power to the CPU and other components.
- Slots for the system's main memory, typically in the form of DRAM chips.
- A chip forms an interface between the CPU, the main memory and other components. On many types of motherboards this is referred to as the Northbridge. This chip also contains a large heat sink.
- *A Second Chip Controls the Input and Output (I/O) Functions*: It is not connected directly to the CPU but to the Northbridge. This I/O controller is referred to as the Southbridge. The Northbridge and Southbridge combined are referred to as the chipset.
- Several connectors, which provide the physical interface between input and output devices and the motherboard. The Southbridge handles these connections.
- *Slots for One or More Hard Drives to Store Files*: The most common types of connections are Integrated Drive Electronics (IDE) and Serial Advanced Technology Attachment (SATA).
- A Read-only memory (ROM) chip, which contains the firmware, or startup instructions for the computer system. This is also called the BIOS.
- *A Slot for a Video or Graphics Card*: There are a number of different types of slots, including accelerated graphics port (AGP) and peripheral component interconnect express (PCIe).
- Additional slots to connect hardware in the form of peripheral component interconnect (PCI) slots.
- Photograph of a typical motherboard with the most important parts labeled
- computer motherboard with labels



There are certainly a lot of acronyms to get used to do not worry too much about trying to remember all the parts and their acronyms. The key is to remember that the motherboard contains the central processing unit, the memory, and all the connectors to the rest of the hardware of the computer system. The board is the 'mother' of all components that is where it gets its name.

BIOS (Basic Input /Output System)

Short for Basic Input /Output System, the BIOS, ROM BIOS, or System BIOS is a chip located on all motherboards that contain instructions and setup for how the system should boot and how it operates. In the picture below, is an example of what a BIOS chip may look like on the computer motherboard. *For example*, this is a picture of an early AMIBIOS, a type of BIOS manufactured by the AMI. Another good example of a BIOS manufacturer is Phoenix.

The BIOS includes instructions on how to load basic computer hardware and includes a test referred to as a POST (Power on Self-Test) that helps verify the computer meets requirements to boot up properly. If the computer does not pass the POST, you will receive a combination of beeps indicating what is malfunctioning within the computer.

The four main functions of a PC BIOS

- *POST*: Test the computer hardware and make sure no errors exist before loading the operating system. Additional information on the POST can be found on our POST and Beep Codes page.
- *Bootstrap Loader*: Locate the operating system. If a capable operating system is located, the BIOS will pass control to it.
- *BIOS Drivers*: Low level drivers that give the computer basic operational control over the computer's hardware.
- *BIOS or CMOS Setup*: Configuration program that allows you to configure hardware settings including system settings such as computer passwords, time, and date.

1.4.1 Common Motherboard Features

Common motherboard features are as follows:

Suitability

While computer evolution accelerates, a well-chosen motherboard performs in areas that you consider most important. According to Computer World, consumers can fit their choice of motherboards to suit their computer uses. Put simply, you may save a lot of money by purchasing a motherboard without all the latest features if you do not need them. If you have kids who are on the leading edge of all things technical, the choice of motherboard could be crucial in determining how long the system will work at optimum performance in the ever-evolving computer world. Consider its fit with other components, such as processors (CPU), graphics cards, memory and ports for peripherals. An inadequate motherboard influences the compatibility and functioning of those components.

Upgradability

A durable motherboard may lengthen the computer's life and save you on peripheral replacement parts. A motherboard is itself upgradable. A consumer's computer needs change, so a consumer can change a PC motherboard (watch out, though, to ensure that component parts plugged into it are still compatible with the new board). For example, video game software demands enhanced motherboard processing capacity. That would cause a consumer to narrow his search for motherboards with such capability. A well-chosen motherboard may allow consumers to upgrade peripheral components without buying a new motherboard. In versatile times, a versatile motherboard makes a good return on investment.

Replacability

A consumer can change motherboards to suit his own time and budget. Once committed to a self-built system, computer users can replace and upgrade any component, motherboard included, with know-how and the turn of a few screws. This allows a consumer to change with the times. If his needs change quickly, he can tap into the latest and greatest motherboard of the time. A consumer with fewer computer needs and a tight budget can pick and choose which component to upgrade with his existing motherboard. A well-designed, adaptable motherboard may allow a computer user to upgrade using only an expansion slot rather than a new motherboard itself.

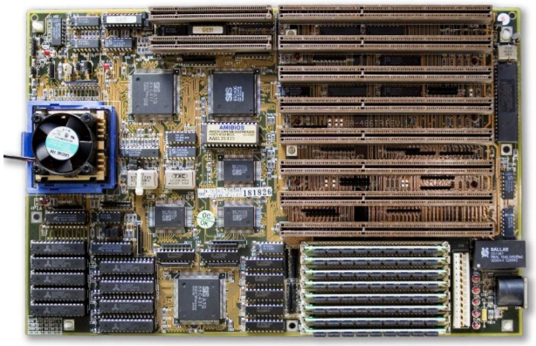
1.4.2 Types of Motherboards

Types of motherboards are as follows:

AT Motherboards

AT stands for Advanced Technology. Advanced Technology Motherboards have PGA (Pin Grid Array) Socket, SD Ram slots, 20pin power connector PCI slots and ISA slots.

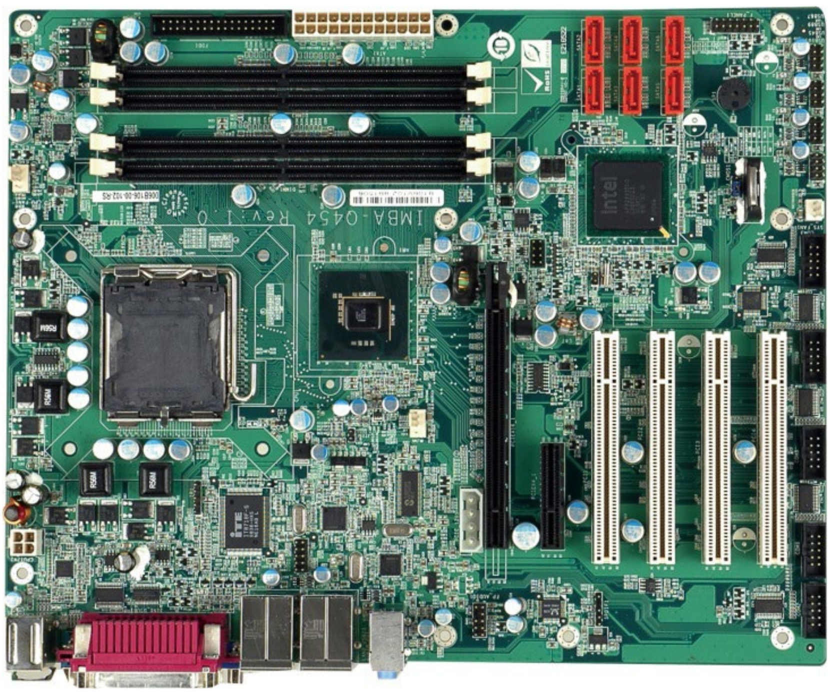
Example: ***Pentium-III Processors***



ATX Motherboards

ATX stands for Advanced Technology extended. Latest motherboards all are called as ATX motherboards and designed by ATX form factor. In these motherboards, we find MPGA Processor Sockets, DDR Ram slots, PCI slots, AGP slots, Primary and secondary IDE interfaces, SATA connectors, 20pin and 24 pin ATX power connector and Ports.

Example: Pentium-IV, Dual Core, Core 2 Duo, Quad Core, i3, i5 and i7 Processors.

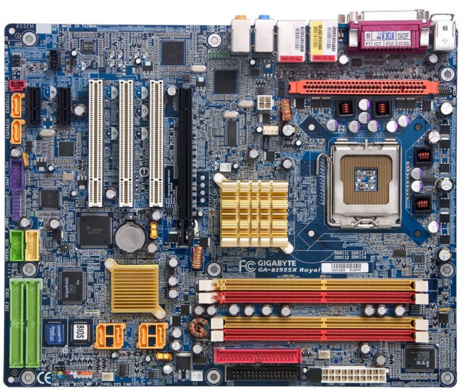


microATX Motherboard

Sometimes referred to as the mATX, the microATX is a motherboard that is 9.6″ wide x 9.6″ deep and capable of being as small as 6.75″ wide x 6.75″ deep. This motherboard was first introduced by Intel in December 1997 and is a smaller motherboard that can be used in either an ATX case or smaller computer case.

Proprietary Motherboards

Several major PC makers, including Hewlett-Packard and Sony, make mother boards that work only with their cases. These proprietary motherboards enable these companies to create systems that stand out from the generic ones and, not coincidentally, push you to get service and upgrades from their authorized dealers. Some of the features you shall see in proprietary systems are riser board’s part of a motherboard separate from the main one, but connected by a cable of some sort and unique power connections. If you work on one of these systems, keep in mind that all PCs function similarly, regardless of how they look. You might not be able to figure out the specific power connection right away, *for example*, but you know that the proprietary system needs power.



1.4.3 Installing a Motherboard

Installing the motherboard in the homebuilt computer usually is pretty easy (though sometimes knuckle-busting). Basically, you just line up the board with the mounting holes and rear-panel openings, and then screw it in. (If you purchased a barebones computer kit the motherboard may already be installed; in which case you can skip this page if you like.)

Read the Manual

Read the manual before actually installing the motherboard, be sure to thoroughly read the motherboard manual to familiarize yourself with the board's layout and connections, to make absolutely sure that it is compatible with the processor and RAM that you will be using, to make sure that the jumper settings, if any, are correct, and to check for any other warnings or instructions.

You would not actually have to do anything to the motherboard. Most modern motherboards have a "jumper-free" option that can be selected (usually by setting a jumper, amusingly enough) that will allow you to control the motherboard settings from the keyboard during CMOS setup. When setting a jumper is required to enable the jumper-free settings, that jumper is usually pre-set that way from the factory.

Determine Which Mounting Holes you will be using

Determine which mounting holes you will need to use. About the only difficult part of installing a motherboard is matching up the mounting holes in the mobo with the ones on the case.

In theory, the mounting hole locations are standardized within a given form factor; but in practice, it is a rare thing to find a case and motherboard whose mounting holes exactly correspond. More often, you will have to look at the mounting holes in the motherboard to determine which mounting holes on the case you will be using.

It is good practice to use all of the motherboard's mounting holes, but you probably would not use all of the case's mounting holes. Chances are that the case will have extra holes to accommodate different boards.

Installing the Standoffs

Three kinds of standoffs, once you have determined which mounting holes you will be using, you will need to insert standoffs in the corresponding holes in the computer case. Chances are that some of them will already be installed, and you will have to install the rest.

There are several types of standoffs, with the ones on the right being the most common. The purpose of standoffs is to separate the back of the motherboard from the metal case. You install the standoffs in the mounting holes in the case that correspond to the holes in the motherboard.

If you do not install the standoffs, then you will most likely damage the motherboard when you try to install it. The standoffs are screwed or inserted into the chassis. The standoffs are screwed or inserted into the chassis, and the mobo in turn is attached to the standoffs through the mounting holes in the motherboard. This creates a small space that prevents the back of the motherboard from shorting out against the metal case.

Again, do not be surprised if the motherboard has extra holes for which there are no corresponding holes in the case. This is normal. Very few cases and motherboards will match exactly. As long as you use all the mounting holes that do match, you shall be fine.

REMEMBER

Standoffs must never be inserted into any of the extra holes, however. Standoffs installed in holes on the case that do not have corresponding holes in the motherboard can cause the motherboard to short out. Finally, do not over-tighten the standoffs. Hand-tight plus a smidgen is enough. Most cases are made of thin metal that can strip if you over-tighten the standoffs.

Install the Motherboard

Line up the motherboard with the rear panel openings and the mounting screws. Once you have the correct standoffs inserted, lay the motherboard into the case, line up the mounting holes and the rear-panel connectors, and screw it down.

Usually, the easiest way to install a motherboard is to lay the motherboard over the standoffs slightly forward of the rear panel connectors, then slide it back into the rear panel connectors until the mounting holes line up. Make sure that you are not snagging any wires, and then screw the board down. Do not over tighten-the screws. You will crack the motherboard if you do, and then it will be useless. The screws should be snug, not excessively tight. Use a standard screwdriver, not an electric one.

Attach the Power Connectors

Do not forget to attach the power connector. Finally, connect the ATX power connector from the power supply to the motherboard. Do this now. If you forget about it and later fire up the computer while the ATX connector is not connected to anything, then you will fry the computer's power supply.

1.5 EXPANSION BUS

External bus or Expansion bus allows the CPU to talk to the other devices in the computer and vice versa. It is called that because it is external to the CPU.

Types of Expansion Buses

ISA

Introduced by IBM, ISA or Industry Standard Architecture was originally an 8-bit bus and later expanded to a 16-bit bus in 1984. When this bus was originally released it was a proprietary bus, which allowed only IBM to create peripherals and the actual interface. Later however in the early 1980's the bus was being created by other clone manufacturers.

Keyword

Expansion Bus: It is use to connect devices to the motherboard and therefore allow the flow of data between that device and other devices in the computer.

PCI

Introduced by Intel in 1992, PCI is short for Peripheral Component Interconnect and is a 32-bit or 64-bit expansion bus. The PCI bus is the most popular expansion bus use in today's computers

AGP

Introduced by Intel in 1997, AGP or Advanced Graphic Port is a 32-bit bus or 64-bit bus designed for the high demands of 3-D graphics. AGP has a direct line to the computer's memory which allows 3-D elements to be stored in the system memory instead of the video memory. AGP is one of the fastest expansion buses in use but it is only for video or graphics environment.

1.5.1 Local Bus

A bus is a computer component, generally a slot attached to the motherboard that enables the flow of information between two or more devices. The local bus, also referred to as an internal bus, is defined as the particular bus that allows for connections to and communication with the motherboard from devices inside the computer. Local devices would include such items as the video card, sound card, and modem. There are multiple architectures employed for a local bus that have gradually evolved as computer technology advances. Most computers contain a number of buses to control input and output (I/O).

Legacy equipment and possibly even some contemporary computers contain an industry standard architecture (ISA) bus, which may or may not have actual slots on the motherboard. ISA was the first standard architecture and is still sometimes used for compatibility with older or slower devices, such as mice and modems.

As computer performance needs increased and the industry shifted from a character-based to a graphic-based system, new bus architectures were developed. The video electronics standards association (VESA) local bus, also known as VLB, came about in 1992. This standard increased the speed of communications and dramatically improved video performance.

Developed and introduced in 1992, the peripheral component interconnects (PCI) local bus quickly became the popular choice for internal buses. The PCI bus provided improved information transfer using a burst mode and improved performance through bus mastering. The PCI standard also facilitated high bandwidth usage. The speed of this type of local bus can be set either synchronously or asynchronously, which gives a user the ability to overclock the system to increase processes.

PCI buses are unable to handle the extreme graphics demands of the modern computing era. Accelerated graphics port (AGP) slots were intended to replace PCI slots. Some consider the AGP slot to be a port rather than a bus, as it connects only two devices, a video card and the motherboard. AGP did not hold the top slot for long, however, as peripheral component interconnect express (PCI-E) entered the ring to become the new standard.

The PCI-E local bus utilizes serial connections that are less susceptible interference. In addition, this standard allows for true bidirectional communication. These factors make PCI-E faster than its predecessors. The scalability and speed of this standard make it the principal local bus architecture for I/O control as of 2011.

1.5.2 Expansion Card

Expansion cards are devices that extend a computer's capabilities and are inserted into expansion interfaces on the motherboard. Once upon a time, practically everything had to be installed into the motherboard as an expansion card. But early on in the history of the PC, manufacturers started adding more and more integrated peripherals right onto the boards; and nowadays, it is possible to buy a board that has everything the processor and the RAM built right in.

Depending on the motherboard you have purchased, however, you shall most likely need to install one or more expansion cards in the homebuilt computer. Many new motherboards have audio, video, and network "cards" built right into them. But if not (or if you do not want to use the integrated cards), then you will need to install expansion cards.

Types of Expansion Cards

There are many different types of expansion cards. The most common of these are as follows:

- *Video Cards, Which Provide a Computer's Visual Output to a Monitor or Other Video Device:* Some video cards also allow input from a video camera, VCR, DVD player, or other video sources.
- *Sound Cards, Which Provide a Computer's Audio Output to Speakers or Other Audio Devices*: Most audio cards also allow sound input to the computer from a microphone or other audio sources.
- Network cards and modems, which allow a computer to be connected (or "networked") to other computers on a local network, or to the Internet.
- *Controller Cards, Such as Hard Drive Controllers*. Although most motherboards have driven controllers built right onto them, controller cards can be purchased which allow the addition of newer or faster drives, RAID arrays, SATA drives, SCSI drives, and so forth to older motherboards that do not feature onboard controllers for these drive types.
- I/O (input/output) cards, which can be used to replace a faulty onboard controller or to add more I/O interfaces (such as USB or Fire-wire interfaces) than were built into the motherboard. I/O cards are an inexpensive way to add a new type of interface to an older, but otherwise serviceable computer.

1.5.3 USB (Universal Serial Bus)

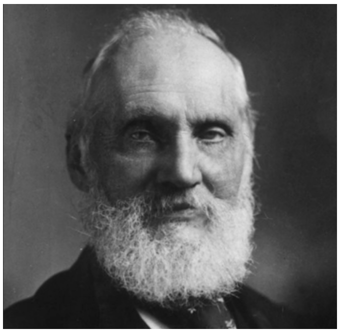
A Universal Serial Bus (USB) is a common interface that enables communication between devices and a host controller such as a personal computer (PC). It connects peripheral devices such as digital cameras, mice, keyboards, printers, scanners, media devices, external hard drives and flash drives. Because of its wide variety of uses, including support for electrical power, the USB has replaced a wide range of interfaces like the parallel and serial port.

A USB is intended to enhance plug-and-play and allow hot swapping. Plug-and-play enables the operating system (OS) to spontaneously configure and discover a new peripheral device without having to restart the computer. As well, hot swapping allows removal and replacement of a new peripheral without having to reboot.

Although there are several types of USB connectors, the majority of USB cables are one of two types, type A and type B. The USB 2.0 standard is type A; it has a flat rectangle interface that inserts into a hub or USB host which transmits data and supplies power. A keyboard or mouse is common examples of a type A USB connector. A type B USB connector is square with slanted exterior corners. It is connected to an upstream port that uses a removable cable such as a printer. The type B connector also transmits data and supplies power. Some type B connectors do not have a data connection and are used only as a power connection.

The USB was co-invented and established by Ajay Bhatt, a computer architect who had been working for Intel. In 1994 seven companies that included Intel, Compaq, Microsoft, IBM, Digital Equipment Corporation (DEC), Nortel and NEC Corporation started the development of the USB. Their objective was to make it easier to connect peripheral devices to a PC and eliminate the mass amount of connectors. Factors involved included: creating larger bandwidths, streamlining software configurations and solving utilization problems for current interfaces.

The USB design is standardized by the USB Implementers Forum (USBIF) that is comprised of a group of companies supporting and promoting the USB. The USBIF not only markets the USB but maintains the specifications and upholds the compliance program. Specifications for the USB were created in 2005 with the 2.0 version. The standards were introduced by the USBIF in 2001; these included the older versions of 0.9, 1.0 and 1.1, which are backward compatible.



ROLE MODEL

SIR WILLIAM THOMSON

Scottish engineer, mathematician, and physicist who profoundly influenced the scientific thought of his generation.

Sir William Thomson Lord Kelvin was an Ireland born scientist, mathematician and engineer who is a stalwart of science and is credited for his pioneering work in the field of thermodynamics as well as in electromagnetism. Sir William had a profound effect on the sciences and made plenty of discoveries that made him one of the greatest scientist of his era, and indeed of all time. He had also worked on telegraphic projects commissioned by the British crown and was successful in producing a mariner's compass that was far more reliable than the ones which were available at the time. There are very few scientists in the history of the world who can match up to the achievements and accomplishments of Sir William Thomson Lord Kelvin. In addition to that, it is also important to point out that his accomplishments have been in great many branches and fields of science; which is why he is counted among the most gifted scientific minds of the last millennium. Sir William was unlike his other contemporaries who dedicate themselves completely towards research in their laboratory, rather he believed he could contribute to the greater good by employing his skills in the field of industrial research. To know more about his life and works read on.

Childhood & Early Life

- William Thomson was born on 26 June, 1824 to James Thomson and Margaret Thomson in Belfast, Ireland. He was the 4th child born to the Thomsons' and showed a gift for the sciences quite early on in his life.
- His father James was a mathematics teacher and William Thomson was initially home schooled. In 1834, at the age of 10, he started studying at 'Glasgow University'; the institute provided elementary school education to willing pupils at the time.

- In the year 1841, William Thomson went up to 'Peterhouse College' at 'Cambridge University' and studied mathematics, physics and pure sciences. He was also an eager sportsman while at Cambridge and in fact was a well-known athlete.

Career

- Right from his days at Cambridge, William Thomson was known as a scientist of rare talent and in 1851 he published a paper in relation to Joule's and Carnot's theories on thermodynamics that was the touchstone of the 'Second Law of Thermodynamics'.
- Between the years 1852 and 1856, he partnered with James Prescott Joule and analyzed the experiments on thermodynamics carried out by the latter. Their collaboration led to plenty of discoveries in thermodynamics including the celebrated 'Joule-Thomson Effect'.
- In 1855, Sir William worked with the leading scientist of the period Michael Faraday on the transatlantic telegraph cable and the duo were also responsible for being the first to propound the concept of the electromagnetic field.
- He was one of the earliest scientists to have devised a method of accurately measuring electric current and in 1857 he published a paper on the electrometer. He went on to invent the 'Kelvin Balance', which was regarded as one of the most accurate measure of the period.
- He worked in two separate periods for the Atlantic cable company; between the years 1857 to 1866. He was involved in the process of laying the cables that would bring about a paradigm shift in how people communicated.
- Once the transatlantic cable was completed; Thomson became the most sought after name in telegraphic communication and was made partner by two engineering firms. This association made him one of the wealthiest scientists of the era.

Major Works

- Sir William Thomson's work on the transatlantic cable remains his biggest legacy that laid the foundations for modern communication technology and it later became one of the bedrocks of communication during the World War.
- He was pioneer on thermodynamics studies and in 1848 was successful in establishing the correct value of 'Absolute Zero', which is the lower limit of temperature. The scale calibrated to measure temperatures is known as the Kelvin scale after him.

Awards & Achievements

- In 1866 Sir William Thomson was knighted by the British monarch in recognition of his sterling work in laying the transatlantic cable.
- In the year 1892, the County of Ayr bestowed on him the title of 'Baron Kelvin of Largs' due to his contribution towards the sciences.

Personal Life & Legacy

- His brother James Thomson was 2 years older than him and also studied at the 'Glasgow University'. James Thomson is a scientist and engineer of great renown in his own right. He was made a Fellow of The Royal Society in 1877.
- In the September of 1952, Thomson married his friend of many years and the daughter of Walter Crum, Margaret Crum however his wife suffered from health problems and that was one something that bothered him immensely. He had no children.
- On 7th December, 1907 at the age of 83, William Thomson, First Baron Kelvin died after suffering from common cold for more than a month.
- He was an extremely wealthy scientist who earned a fortune after partnering with two engineering firms in relation to his project on telegraphs. He owned a huge estate and was also the owner of a 126 ton yacht.

Trivia

- Sir William Thomson was a great devotee of the authors of the classics of literature and was known to quote them when he wanted to make a point.
- The name Kelvin is derived from the name of the river Kelvin that flows close to the 'University of Glasgow'.

SUMMARY

- Computer components like the CPU, motherboard, computer case, RAM and drive are the core of a computer. They determine the capabilities and features of a computer, as well as its power and processing speeds.
- When building a PC, it's finding the best PC components that will really test your patience and endurance. That's especially with so many options to choose from and manufacturers rolling out new ones every few months. In fact, the act of building a PC itself may be the easier part of the process.
- A computer system unit is the enclosure that contains the main components of a computer. It is also referred to as computer case or tower. A typical desktop computer consists of a computer system unit, a keyboard, a mouse, and a monitor.
- The monitor is the piece of computer hardware that displays the video and graphics information generated by the computer through the video card.
- Liquid crystal display, also known as liquid crystal diode, is one of the most advanced technologies available at present. Typically, an LCD monitor consists of a layer of color or monochrome pixels arranged schematically between a couple of transparent electrodes and two polarizing filters.
- The keyboard is the piece of computer hardware used to input text, characters and other commands into a computer or similar device. Keyboard is basically a board of keys. Along with the mouse, the keyboard is one of the primary input devices used with a computer.
- A mouse is a small device that a computer user pushes across a desk surface in order to point to a place on a display screen and to select one or more actions to take from that position.
- The central processing unit (CPU) is the component that performs all calculations and mathematical manipulations in a computer.
- Random-access memory is a form of computer data storage. A random-access memory device allows data items to be read and written in roughly the same amount of time regardless of the order in which data items are accessed.

KNOWLEDGE CHECK

1. **What's the best way to protect your hard drive data?**
   a. regular backups
   b. periodically defrag it
   c. run chkdsk at least once a week
   d. run scandisk at least once a week
   e. run a regular diagnostic
2. **On a dot matrix printer, you should never lubricate which part?**
   a. carriage rails
   b. printhead pins
   c. paper advance bearings
   d. carriage bearings
   e. None of the above
3. **How many devices can be used on a single SCSI bus? Keep in mind that the SCSI host adapter counts as a device.**
   a. 1
   b. 8
   c. 20
   d. 10
   e. All of the above
4. **Match the device driver HIMEM.SYS to its operation.**
   a. Supports (ANSI) terminal emulation
   b. Manages the use of extended memory
   c. Uses expanded memory on a 80386 processor
   d. Supports code page switching
   e. None of the above
5. **_____ help prevent power surges.**
   a. Surge suppressor
   b. Spike protector
   c. UPS system
   d. High-grade multi-meter
   e. None of the above

6. Which is the critical processing component in any computer?

a. Mouse

b. Keyboard

c. Memory devices

d. DVD

7. Which is the main memory of computer?

a. CD

b. DVD

c. Internal hard drive

d. RAM

8. What is the name of the circuit board that contained within the processor of computer?

a. Motherboard

b. Central processing unit

c. Microprocessor

d. Chipboard

REVIEW QUESTIONS

1. Explain the major components of a PC.
2. Define the monitor and also its types.
3. Discuss about the central processing unit (CPU).
4. Explain about the motherboard and BIOS.
5. Describe the expansion bus and also its type.
6. Write shorts notes on:
   - local bus
   - USB (Universal Serial Bus)

Check Your Result

1. (a)	2. (b)	3. (b)	4. (b)	5. (a)
6. (c)	7. (c)	8. (b)		

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CHAPTER 2

BASICS OF SOFTWARE AND HARDWARE

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define software and hardware
2. Explain the type of software
3. Describe the open source software
4. Explain the integrated development environment
5. Understand the need of software

"Software innovation, like almost every other kind of innovation, requires the ability to collaborate and share ideas with other people, and to sit down and talk with customers and get their feedback and understand their needs."

—Bill Gates

INTRODUCTION

A computer is a general-purpose electronic counting device used in data processing because of its accuracy and high speed. The physical components of a computer system are called the hardware, which includes the central processing unit and peripheral equipment for data input, output, and storage. Computer capacity is measured by the amount of data that can be stored in main memory and by the computer word size. Performance is indicated by the speed with which instructions are executed. Input devices (e.g., keyboard-type terminals) are the components that accept raw data and convert it into electronic form, and output devices (e.g., video display terminals) present the results of data processing in human-readable form.

System software is the set of instructions that facilitate hardware use and allow the application software, which solves specific user problems, to run efficiently. System and application software is written by using various machine and symbolic languages. Milestones in software-development techniques include program subroutine use, modular programming, functional decomposition, structured programming, and structured analysis. Objectives in improving software quality are reducing development costs, making maintenance easier, and making development results more predictable. Because software development has lagged behind revolutionary advances in hardware, the full potential of computers has yet to be realized.

The term hardware refers to mechanical device that makes up computer. Computer hardware consists of interconnected electronic devices that we can use to control computer's operation, input and output. Examples of hardware are CPU, keyboard, mouse, hard disk, etc. Computer hardware is a collection of several components working together. Some parts are essential and others are added advantages.

2.1 SOFTWARE AND HARDWARE

Keyword

Computer hardware is the collection of physical components that constitute a computer system.

A computer cannot do anything on its own. It must be instructed to do a job desired by us. Hence, it is necessary to specify a sequence of instructions a computer must perform to solve a problem. Such a sequence of instructions written in a language understood by a computer is called a computer program. A program controls a computer's processing activity, and the computer performs precisely what the program wants it to do. When a computer is running a program to perform a task, we say, it is running or executing that program. "Hardware you can touch, software you cannot". The term software refers to a set of computer programs, procedures, and associated documents (flowcharts, manuals, etc.) describing the programs, and how they are to be used. Software package is a group of programs that solve a specific problem or perform a specific type of job.

For sample, a word-processing package may contain programs for text editing, text formatting, drawing graphics, spelling checking, etc. Hence, a multipurpose computer system, like a personal computer in home, has several software packages, one each for every type of job it can perform.

Software is a collection of instructions that enables a user to interact with the computer or have the computer perform specific tasks for them. Without any software the computer would be useless.

Hardware

Hardware refers to the physical elements of a computer. This is also sometime called the machinery or the equipment of the computer. Examples of hardware in a computer are the keyboard, the monitor, the mouse and the processing unit. However, most of a computer's hardware cannot be seen; in other words, it is not an external element of the computer, but rather an internal one, surrounded by the computer's casing (tower). A computer's hardware is comprised of many different parts, but perhaps the most important of these is the motherboard. The motherboard is made up of even more parts that power and control the computer.

In contrast to software, hardware is a physical entity. Hardware and software are interconnected, without software; the hardware of a computer would have no function. However, without the creation of hardware to perform tasks directed by software via the central processing unit, software would be useless.

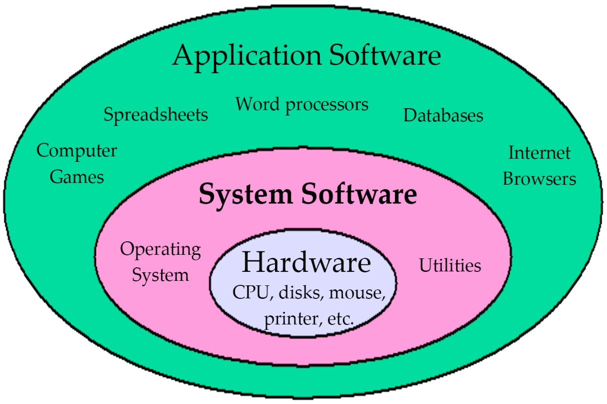
Hardware is limited to specifically designed tasks that are, taken independently, very simple. Software implements algorithms (problem solutions) that allow the computer to complete much more complex tasks.

Keyword

Computer software, or simply software, is a part of a computer system that consists of data or computer instructions, in contrast to the physical hardware from which the system is built.

2.1.1 Relationship between Hardware and Software

For a computer to produce useful output its hardware and software must work together. Nothing useful can be done with the hardware on its own, and software cannot be utilized without supporting hardware.



Can a computer run without software?

In most situations, yes, a computer can run without **software** being installed. However, if an operating system or interpreter is not found on the computer it would either generate an error or sit at a black screen. Installing additional programs onto the computer after the operating system has been installed will only give those computer additional abilities.

For example, a word processor is not required, but will allow you to create documents and letters.

How to install a software program?

How to install a software program can depend on the operating system being used and the program being installed. Because of all the different possibilities, we have created the above for installing programs in each of the major operating systems.

Computer hardware is any physical device, something that we are able to touch and software is a collection of instructions and code installed into the computer and cannot be touched.

For example, the computer monitor we are using to read this text on and the mouse we are using to navigate this web page is computer hardware. The Internet browser that allowed visiting this page and the operating system that the browser is running on is software.

Can a computer run without hardware?

Depends on the hardware. Almost all computer setups will require at least a disk drive (e.g. hard drive), display, keyboard, memory, motherboard, processor, power supply, and video card in order to function properly. If any of these devices was missing or had problems, an error would be encountered, or the computer would not start. Adding other hardware such as a disc drive (e.g. CD-ROM or DVD), modem, mouse, network card, printer, sound card, speakers, etc. are not required, but will give the computer additional capabilities.

To take an analogy, a cassette player and its cassettes purchased from the market are hardware. However, the songs recorded on the cassettes are its software. To listen to a song, that song has to be recorded on one of the cassettes first, this is then mounted on the cassette player and played. Similarly, to get a job done by a computer, the corresponding software has to be loaded in the hardware first and then executed.

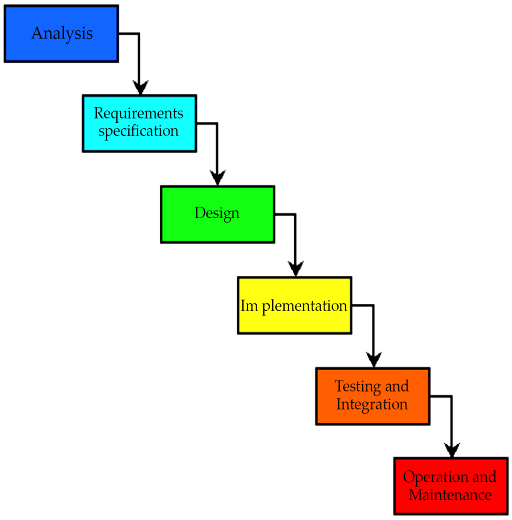
Following important points regarding the relationship between hardware and software are brought out by this analogy:

1. Both hardware and software are necessary for a computer to do useful job. Both are complementary to each other.
2. Same hardware can be loaded with different software to make a computer perform different types of jobs just as different songs can be played using the same cassette player.
3. Except for upgrades (like increasing main memory and hard disk capacities, or adding speakers, modems, etc.), hardware is normally a one-time expense, whereas software is a continuing expense. Like we buy new cassettes for newly released songs or for songs whose cassettes, we do not have, we buy, new software to be run on the same hardware as and when need arises, or funds become available.

2.1.2 Software Development Steps

All software needs to be developed by someone. Developing software and putting it to use is a complex process involving following steps:

1. Analyzing the problem at hand, and planning the program(s) to solve the problem.
2. Coding the program(s)
3. Testing, debugging, and documenting the program(s)
4. Implementing the program(s)
5. Evaluating and maintaining the program(s)



2.2 TYPES OF SOFTWARE

Although the range of software available today is vast and varied, most software can be divided into three major categories:

1. System software
2. Application software
3. Programming software

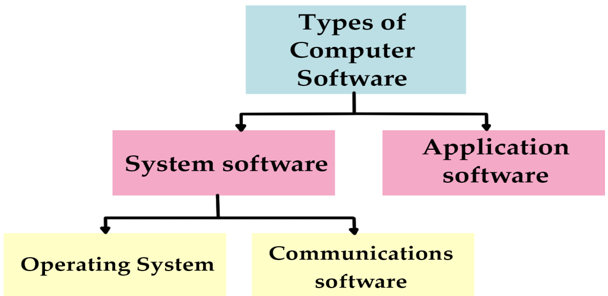


Figure 2.1: Type of software.

2.2.1 System Software

System software is a set of one or more programs designed to control the operation and extend the processing capability of a computer system. In general, a computer's system software performs one or more of the following functions:

- Supports development of other application software.
- Supports execution of other application software.
- Monitors effective use of various hardware resources such as CPU, memory, peripherals, etc.
- Communicates with and controls operation of peripheral devices such as printer, disk, tape, etc.

Hence, system software makes the operation of a computer system more effective and efficient. It helps the hardware components work together, and provides support for the development and execution of application software (programs). The programs included in a system software package are called system programs. The programmers who prepare system software are referred to as system programmers.

Some commonly known types of system software are:

Operating Systems: Operating system software takes care of effective and efficient utilization of all hardware and software components of a computer system.

Programming Language Translators: Programming language translators transform the instructions prepared by programmers in a programming language into a form that can be interpreted and executed by a computer system.

Communications Software: In a network environment (where multiple computers are interconnected together by communications network) communications software enables transfer of data and programs from one computer system to another.

Utility Programs: Utility programs (also known as utilities) are a set of programs that help users in system maintenance tasks, and in performing tasks of routine nature. Some tasks commonly performed by utility programs include formatting of hard disks or floppy disks, taking backup of files stored on hard disk on to a tape or floppy disk, sorting of the records stored in a file based on some key field(s), etc.

DID YOU KNOW ?

In the late 1940s, the early days of computing, most application software was custom-written by computer users to fit their specific hardware and requirements. System software was usually supplied by the manufacturer of the computer hardware and was intended to be used by most or all users of that system.

2.2.2 Application Software

Application software is a set of one or more programs designed to solve a specific problem, or do a specific task.

For example, payroll processing software, examination results processing software, railway/airline reservation software, computer games software are all application software. Similarly, a program written by a scientist to solve a research problem is also application software. The programs included in an application software package are called application programs. The programmers who prepare application software are referred to as application programmers.

There is literally millions of application software available for a wide range of applications. They range from simple applications such as word processing, inventory management, preparation of tax returns, banking, hospital administration, insurance, publishing, to complex scientific and engineering applications such as weather forecasting, space shuttle launching, oil and natural gas exploration, design of complex structures like aircrafts, ships, bridges, sky-rise buildings, etc. With so many applications available, it is not possible to categorize them all and to cover them here. Some commonly known application software is:

Word-Processing Software: Word-processing software enables us to make use of a computer for creating, editing, viewing, formatting, storing, retrieving, and bringing documents (written material, such as letters, reports, books, etc.).

Spreadsheet Software: Spreadsheet software is a numeric-data-analysis tool that allows us to create a kind of computerized ledger. A manual ledger is a book having rows and columns that accountants use for keeping a record of financial transactions and for preparing financial statements.

Database Software: A database is a collection of related data stored and treated as a unit for information retrieval purposes. *A* database software is a set of programs that enable us to create a database, maintain it (add, delete, and update its records), organize its data in desired fashion (for example, sort its records alphabetically name-wise), and selectively retrieve useful information from it.

For example, queries such as get the telephone number of the person named Adam from the address database, or get the names of all currently enrolled students whose birthdays fall today from the student database can be handled easily.

Graphics Software: Graphics software enables us to use a computer system for creating, editing, viewing, storing, retrieving, and printing of designs, drawings, pictures, graphs, etc.

Personal Assistance Software: Personal assistance software allows us to use personal computers for storage and retrieval of our personal information, as well as planning and management of schedules, contacts, finances, and inventory of important items.

Education Software: Education software allows a computer to be used as a teaching and learning tool. A few examples of such software include those used for teaching mathematics, grammar, language, or any other subject.

Entertainment Software: Entertainment software allows a computer to be used as an entertainment tool. Computer video games belong to this category of software.

2.2.3 Programming Software

Programming software usually provides tools to assist a programmer in writing computer programs, and software using different programming languages in a more convenient way.

The tools include:

Compilers

A compiler is a computer program (or set of programs) that transforms source code written in a programming language (the source language) into another computer language (the target language, often having a binary form known as object code). The most common reason for wanting to transform source code is to create an executable program.

Debuggers

A debugger or debugging tool is a computer program that is used to test and debug other programs (the "target" program). The code to be examined might alternatively be running on an instruction set simulator (ISS), a technique that allows great power in its ability to halt when specific conditions are encountered but which will typically be somewhat slower than executing the code directly on the appropriate (or the same) processor. Some debuggers offer two modes of operation full or partial simulation, to limit this impact.

Interpreters

An interpreter normally means a computer program that executes, i.e. performs, instructions written in a programming language. An interpreter may be a program that either:

- Executes the source code directly
- Translates source code into some efficient intermediate representation (code) and immediately executes this
- Explicitly executes stored precompiled code made by a compiler which is part of the interpreter system

Linkers

A linker or link editor is a program that takes one or more objects generated by a compiler and combines them into a single executable program.

Text Editors

A text editor is a type of program used for editing plain text files. Text editors are often provided with operating systems or software development packages, and can be used to change configuration files and programming language source code.

2.3 OPEN SOURCE SOFTWARE

Open source software (OSS) is computer software that has its underlying 'source-code' made available under a license. This can allow developers and users to adapt and improve it. Policy on the use of OSS in government was updated in 2004. This briefing explains how OSS works, outlines current and prospective uses and examines recent policy developments. It discusses its advantages and disadvantages and examines factors affecting uptake.

Computer software can be broadly split into two development models:

Proprietary or 'closed' software, owned by a company or individual. Copies of the 'binary' are made public; the 'source-code' is not usually made public.

Open source software (OSS), where the source-code is released with the binary. Users and developers can be licensed to use and modify the code, and to distribute any improvements they make.

In practice, software companies often develop both types of software. OSS is developed by an on-going, iterative process where people share the ideas expressed in the source-code. The aim is that a large community of developers and users can contribute to the development of the code, check it for errors and bugs, and make the improved version available to others. Project management software is used to allow developers to keep track of the various versions.

Both OSS and proprietary approaches allow companies to make a profit. Companies developing proprietary software make money by developing software and then selling licenses to use the software, for example Microsoft receives a payment for every copy of Windows sold with a personal computer. The OSS companies make their money by providing services, such as advising clients on the version that best suits their needs, installing and customizing software and development and maintenance.

The software itself may be made available at no cost.

There are two main types of OSS licenses:

Berkeley Software Distribution (BSD) License: this permits a licensee to 'close' a version (by withholding the most recent modifications to the source-code) and sell it as a proprietary product;

The GNU General Public License (GNU or GPL): under this license, licensees may not 'close' versions. The licensee may modify copy and redistribute any derivative version, under the same GPL license. The licensee can either charge a fee for this service or work free of charge.

REMEMBER

Open-source software is a prominent example of open collaboration, meaning any capable user is able to participate Online in development, making the number of possible contributors indefinite. The ability to examine the code facilitates public trust into the software.

Desirable Software Attributes

There is widespread debate over the relative merits of proprietary software and OSS. However, it is difficult to make general comparisons; most analysts say comparisons should be made only on a case-by-case basis.

It is generally agreed that whether software is open source or proprietary, the following attributes are of key importance:

- *Reliability*: Defined as how long a system can stay in operation without user intervention;
- *Quality*: Commonly defined as the number of errors in a fixed number of lines of code;
- Security: How resilient the software is to unauthorized actions (e.g. viruses);
- *Flexibility*: How easily the software can be customized to meet specific needs and run on different types of device;
- *Project Management*: How well organized the development process is; open standards: documents created with one type of software being readable in another. This avoids 'lock- in' to a particular document format.

- *Switching Costs*: the cost of moving from one system to another;
- *Total cost of ownership (TCO)*: The full costs incurred over the lifetime of the software;
- *User-friendliness*: How easy the software is to use?

Advocates of OSS argue that, because it harnesses a large team of developers, bugs and errors can be rapidly spotted and fixed, thus increasing reliability and security. They also say that having a large team means that OSS is by necessity 'modular' (made up of discrete units, each with a specific function). Modularity simplifies software design and can increase the reliability as well as flexibility of software. Advocates also argue that, by making the source-code available with the software, there is no danger of 'lock-in' because document formats are transparent. However, critics point out that proprietary software can also have a high degree of reliability, flexibility and security and can also conform to open standards.

Many commentators argue that OSS projects can suffer from weak project management (because of their complex development structure) and that OSS can be difficult to use. The OSS community point out that new project management tools are being introduced and that efforts are being made to increase the 'user-friendliness' of OSS desktop applications. There are often concerns that OSS is unsupported, and contains unauthorized intellectual property (IP) belonging to third parties. However the OSS community says this can also be the case with proprietary software. Moreover, large firms such as IBM and Hewlett Packard now manage open source projects and indemnify users to give them added insurance.

2.3.1 Use of Open Source Software

The Private Sector

There is increasing awareness and uptake of OSS within the private sector, with OSS and proprietary software becoming increasingly interwoven. Major corporations such as IBM believe it enables them to make use of a worldwide community of developers to improve their products and services. Some industry commentators suggest that OSS will lead to a more competitive software industry. Currently over 67% of web-servers run open source software called Apache. The majority of websites and email systems run on OSS. Worldwide, around 30% of infrastructural computers run GNU/Linux, an open source operating system. However, use of OSS on the desktop is more limited: over 96% of desktop computers still use Microsoft Windows. The OSS has inspired new portable device projects, such as the 'Simputer'. This is a small, inexpensive, handheld computer, intended to bring computing power to India and other emerging economies.

Open Source Software in Government

Governments' interest in OSS is increasing, due to their reliance on sophisticated software. The UK Office of Government Commerce released a series of case studies in October 2004 outlining how OSS has been used in the public sector. However, UK parliamentary responses to questions on the use of OSS in government show that uptake is still limited. The Office of the Deputy Prime Minister is funding the 'Open Source Academy' project. This is intended to overcome barriers to uptake of OSS in local government such as lack of information, skills, confidence and lack of suitable products.

- Policy on use of OSS within government is outlined in the updated e-Government Unit's policy document released in October 2004.
- Key points are:
- Re-affirmation of the UK Government's commitment to 'procurement neutrality': OSS solutions should be considered alongside proprietary ones in IT procurements;
- Contracts will be awarded on a case-by-case basis, based on value for money. The UK Government will seek to avoid 'lock-in' to proprietary IT products.

2.3.2 Other Usage

Advocates of OSS argue that, in principle, the OSS model allows software to be developed for minority markets, that is, product development can be need-driven rather than market-driven. In practice, it is not clear there is such a clear distinction between the two models: for example both GNU/Linux and Windows now have versions in a number of minority languages.

2.3.3 Open Source Culture

The principle of open source can be applied to a variety of other applications as well as software development. Some commentators believe that several sectors of government and industry could benefit from the open source approach. The ideas behind it are spreading into pharmaceutical drug production; music; book and journal publishing; television broadcasting and many other cultural areas. The BBC is planning to make some material available in a 'creative archive' for viewing, copying and reuse but with some rights reserved, such as commercial exploitation.

2.4 INTEGRATED DEVELOPMENT ENVIRONMENT (IDE)

An integrated development environment (IDE) (also known as integrated design environment, integrated debugging environment or interactive development environment) is a software application that provides comprehensive facilities to computer programmers for software development. An integrated development environment (IDE) is a programming environment that has been packaged as an application program, typically consisting of a code editor, a compiler, a debugger, and a graphical user interface (GUI) builder. The IDE may be a standalone application or may be included as part of one or more existing and compatible applications. The basic programming language, for example, can be used within Microsoft Office applications, which makes it possible to write a Word Basic program within the Microsoft Word application. The IDEs provide a user-friendly framework for many modern programming languages, such as Visual Basic, Java, and Power Builder.

The IDE is a standard electronic interface used between a computer motherboard's data paths or bus and the computer's disk storage devices. The IDE interface is based on the IBM PC Industry Standard Architecture (ISA) 16-bit bus standard, but it is also used in computers that use other bus standards. Most computers sold today use an enhanced version of IDE called enhanced integrated drive electronics (EIDE). In today's computers, the IDE controller is often built into the motherboard. IDE was adopted as a standard by American National Standards Institute (ANSI) in November, 1990.

The IDEs for developing HTML applications are among the most commonly used.

For example, many people designing Web sites today use an IDE (such as Home Site, Dream Weaver, or FrontPage) for Web site development that automates many of the tasks involved.

An IDE normally consists of:

- A source code editor
- A compiler and/or an interpreter build automation tools
- A debugger

The boundary between an integrated development environment and other parts of the broader software development environment is not well-defined. Sometimes a version control system and various tools are integrated to simplify the construction of a GUI. Many modern IDEs also have a class browser, an object inspector, and a class hierarchy diagram, for use with object-oriented software development.

Typically an IDE is dedicated to a specific programming language, allowing a feature set that most closely matches the programming paradigms of the language. However, there are some multiple-language IDEs, such as Eclipse, Active State Komodo, IntelliJ IDEA, and Oracle JDeveloper, recent versions of Net Beans, Microsoft Visual Studio, Genuitec My Eclipse, Win Dev, and Xcode.

The IDEs typically present a single program in which all development is done. It typically provides many features for authoring, modifying, compiling, deploying and debugging software. The aim is to abstract the configuration necessary to piece together command line utilities in a cohesive unit, which theoretically reduces the time to learn a language, and increases developer productivity.

REMEMBER

The IDEs are designed to maximize programmer productivity by providing tightly-knit components with similar user interfaces. This should mean that the programmer has to do less mode switching versus using discrete development programs. However, because an IDE is a complicated piece of software by its very nature, this higher productivity only occurs after a lengthy learning process.

2.5 NEEDS OF SOFTWARE

The problem with computers is that most of us do not speak their language. We need a translator, something that can understand our needs and put the computer to work for us. The translator is called software and it makes computers useful.

Look at it this way. Like a typewriter, a computer without software is just a lifeless machine. By adding software, the computer becomes more alive, easy to use, and built for us. Most computers have two basic kinds: The operating system and software programs.

If we want to use a computer, we have to use an operating system. From saving files, to using a mouse or fixing problems, the operating system covers the basics. Operating systems come with all new computers and do a lot of same things. We have seen those called Windows, Mac and Linux.

But the operating system is only part of what we need. To make them personalized and more useful, we can add software programs.

example

If we need to edit a photo we can add a software program that is built for that purpose. If we need to design a house, we can add a software program that lets we see the house from all sides. By adding and removing software programs, we can make the computer fit with exactly what we want to do. And adding most software programs is easy. We can get them from a computer store or download them from the Internet. No computer nerds required.

What is a software program? What is really happening when one opens one? Think about it this way. Computers are really good at following instructions. And a software program is essentially a set of instructions that tells the computer exactly what to do?

When one open a program, the computer goes to work, completing the instructions until the program is ready for use.

The ability to add and remove software programs means that everyone's computer can be different and unique to them.

Now we have talked about operating systems that take care of the basics, and software programs that make computers personalized. It is combination that makes computers so useful. But it is not limited to computers on desk.

Consider cell phone, just like a computer without software, it is a lifeless machine that does not speak our language. Cell phones have software that brings them to life.

The same thing is true for many cameras, music players, and even our cars. Every day we rely on software to bring machines to life and make them personalized and useful.

ROLE MODEL

JOHN VON NEUMANN

American mathematician, physicist, inventor, computer scientist, and polymath.

John von Neumann was a Hungarian-American mathematician, physicist, inventor, computer scientist, and polymath. Born in Budapest into a Jewish family, he shifted to the USA before the rise of Nazi power. There he started teaching mathematics in Princeton University, but was not successful as a professor mainly because his students found it hard to keep up with his speed. Later, as he joined a non-teaching position at the Institute of Advanced Study which closely collaborates with Princeton University, he began to flourish truly. Although he began his career as a pure mathematician, he later became more interested in applied mathematics, and as the Second World War broke out, he used his knowledge to contribute to war efforts. Throughout his life, he had published over 150 papers. Among them, sixty were in pure mathematics; another sixty in applied mathematics; twenty in physics and the rest were on miscellaneous subjects. He was a prolific writer and his last book, written from hospital bed, was published posthumously as 'The Computer and the Brain'.

Childhood & Early Life

- John von Neumann was born as Neumann János Lajos on December 28, 1903 into an affluent family in Budapest. His father, Miksa Neumann, was a banker. His mother, Kann Margit, came from a prosperous merchant family. He had two younger brothers, Michael and Nicholas.
- Born a child prodigy, he could mentally divide and multiply multi-digit numbers from the age of six and became familiar with differential and integral calculus by the age of eight. Besides, he received lessons in Hungarian, English, French, German and Italian while studying at home under a governess.
- In 1911, János was admitted to Fasori Evangélikus Gimnázium. Here his mathematical talent was quickly

spotted by his teacher. Since his father insisted that he studied in grades appropriate to his age, additional especial tuitions were arranged for him to train him in fields in which he displayed an aptitude.

- Neumann completed his education at the gymnasium in 1921. Although he wanted to study mathematics his father convinced him to study chemical engineering because it had better prospects. With that aim, he enrolled at the University of Berlin in 1921 for a two-year course in chemistry.
- Simultaneously, he also enrolled at the University of Budapest with mathematics; but did not attend the classes there. Sometime now, he published two major mathematical papers.
- The first paper, written jointly with Fekete, an assistant professor at the University of Budapest who had been tutoring him, was published in 1922. His second paper was published in 1923. In it, he provided the definition of ordinal number, which is still in use.
- Also in 1923, after completing the two year course at Berlin, Neumann entered Eidgenössische Technische Hochschule Zürich to study chemical engineering. Sometime during this period, he also passed out from the University of Budapest with brilliant results.
- Thereafter, along with studying chemical engineering at ETH Zurich he started his doctoral work in mathematics at Pázmány Péter University in Budapest. In 1926, he graduated from ETH Zurich. Soon after that, he also received his PhD degree from Pázmány Péter. His dissertation was on axiomatization of Cantor's set theory.
- Neumann then joined University of Göttingen to study mathematics under David Hilbert on a grant from the Rockefeller Foundation. On December 13, 1927 he completed his habilitation. By then he had published twelve major papers in mathematics.

Early Career in Europe

- In 1928, Neumann started his career as a privatdozent at the University of Berlin. In the same year, he published 'ZurTheorie der Gesellschaftsspiele' (On the Theory of Parlor Games), an important paper in the field of game theory.
- All along, he kept on working with Hilbert. The work culminated into his first major book, 'The Mathematical Foundations of Quantum Mechanics'; however, it was published much later in 1932.
- In 1929, Neumann shifted to University of Hamburg as privatdozent because it offered better scope to become a tenured professor. However, he did not continue there for long.

- In October 1929, he was invited to lecture on quantum theory at the Princeton University in New Jersey, USA. He accepted the offer; but since he was engaged to be married, he first went to Budapest to complete the ceremony and then moved to USA with his wife.

At Princeton University, USA

- In 1930, Neumann became a visiting lecturer at Princeton University. Some time now, he started working on the theory of rings of operators with the aim of developing a mathematical technique suitable for quantum phenomenon. The work took almost a decade to finish and is now known as 'von Neumann algebras'.
- In 1931, he was appointed a full professor. He now began to write a series of articles in which he made foundational contributions to quasi ergodic theory.
- However, as a professor of mathematics, he was not very popular with the students. This was because they could not keep up with him and found it hard to follow his fluid lines of thought. He wrote too quickly and rubbed it off before his students could copy it.
- Contrarily, he was able to convey the complicated ideas in physics much more easily. After a talk, his students always returned with the feeling that the problem was actually very simple.
- In 1933, the Institute of Advance Study was established at Princeton. Neumann became one of the six original Professors in Mathematics at the institute, a position he maintained throughout his life. In the same year, he also became co-editor of the 'Annals of Mathematics.'
- Until 1933, every summer he used to return to Germany, where he maintained his academic position. However, with the rise of the Nazis in Germany, he thought it prudent to resign and shifted permanently to Princeton.
- In 1935, he became co-editor of 'Compositio Mathematica.' Concurrently, he also functioned as the co-editor of Annals of Mathematics and held both these positions until his death.
- In 1937, he became a naturalized citizen of the United States of America. Around this time he also anglicized his name into John and added von Neumann as a mark of German nobility.
- From 1937 to 1939, von Neumann concentrated on the Lattice Theory, in which he provided an abstract exploration of dimension in complemented modular topological lattices and later founded the field of continuous geometry based on it.

During Second World War

- By late the 1930s, von Neumann had developed an expertise in explosions and became known as the leading authority of the mathematics of shaped charges. Later as the Second World War set in, he decided to join the United States Army, but was rejected because of his age.
- Instead, because of his expertise in the mathematics of shaped charges, he was invited to work as a consultant in a number of military projects. Then in late 1943, he was invited to join the Manhattan Project.
- At Manhattan, Neumann mainly worked on the explosive lenses, which are capable of compressing the plutonium core of the 'Fat Man', the nuclear bomb that was dropped on Nagasaki. He not only provided the concept, but also contributed to its design. Later as the committee was set up to choose the target cities, Neumann was inducted in it.
- Moreover, he also oversaw calculations concerning the impact of the bomb blast, e.g. the estimated size of the blast, expected death tolls, the distance at which the bomb should be denoted for the maximum effect, etc.

Post War Period

- In the post war period, Neumann began to work as a consultant both to the government and the industry. In fact, he started this work even before the end of the War. In 1944, for example, he worked with the U.S. Army contributing important ideas to the development of the hard-wired ENIAC computer.
- Later, he worked as a consultant to the RAND Corporation, a think tank charged with planning nuclear strategy for the U.S. Air Force. In this capacity, he supported building of hydrogen bombs. Around 1950, he also advocated nuclear strike to destroy Soviet Union's nuclear capability.
- In 1954, Neumann was elected a member of the Atomic Energy Commission. He served in that capacity till 1956. During this period, he worked to develop the policy of nuclear deterrence for President Dwight D. Eisenhower's administration.

Major Works

- Von Neumann was the founder of many theories such as the Ergodic Theory, the Operator Theory, the Lattice Theory, Game Theory and the Measure Theory as well as a branch of geometry known as continuous geometry and the Von Neumann Algebras.
- 'Theory of Games and Economic Behavior', which Neumann had co-authored with economist Oskar Morgenstern, is however his most significant work. The book, published in 1944, created the interdisciplinary research field of game theory. The work was based on Neumann's 1928 research work, 'On the Theory of Parlor Games'

Awards & Achievements

- John von Neumann had received several awards; among them Bôcher Memorial Prize (1938), Navy Distinguished Civilian Service Award (1946), Medal for Merit (1946), Medal of Freedom (1956) and Enrico Fermi Award (1956) are the most significant.

Personal Life & Legacy

- On January 1, 1930, von Neumann married Mariette Kövesi, who had studied economics at Budapest University. Soon after that, they shifted to the U.S.A, where their only child, Marina von Neumann Whitman, was born. The couple divorced in 1937.
- Marina later grew up to be noted economist. She is now a Professor of Business Administration and Public Policy at the University of Michigan's Ross School of Business as well as The Gerald R. Ford School of Public Policy.
- In October 1938, von Neumann married Klara Dan, a scientist, and a pioneering computer programmer. The couple did not have any children. They remained married until his death in 1957.
- In 1955, von Neumann was diagnosed with cancer and his health deteriorated very quickly. In spite of that, he continued to work and in 1956, in an essay written for James Newman's 'The World of Mathematics', he defended applied mathematics.
- During his last days, fearing that he might reveal military secrets under medication, he was provided with military security. He died on February 8, 1957 at the Walter Reed Army Medical Center in Washington DC.
- Apart from numerous mathematical formulas named after von Neumann, his legacy is being carried forward by a number of awards and lectures instituted in his honor.

- A lunar impact crater that lies on the far side of the Moon, in the northern hemisphere, has also been named Von Neumann after him.
- In 2005, he was depicted on 37-cent self adhesive US postage stamp, issued by United States Postal Service.

Trivia

- Unlike most mathematicians, von Neumann worked better under chaotic conditions in living rooms and such places rather than in his study, which was rather secluded. He liked to socialize a lot and entertained regularly at home.

CASE STUDY

SOFTWARE PROJECT MANAGEMENT IN INDUSTRY – EXPERIENCES AND CONCLUSIONS

INTRODUCTION Many software projects are faced with a common situation: They fail in developing the required functionality within their schedule and planned budget; the results often lack the required quality. Thus, during the last years several companies have started initiatives to improve their software development. These initiatives mostly focus on improving the software processes and the technology used during software development. One area often underestimated but crucial for every software development project is project management. Project management is one of the key factors influencing the project success or failure. In this paper we present and discuss the findings of two case studies on project management in industrial software development and the conclusions drawn from it. These studies were motivated by the company's goal to improve software project management. Before an improvement program could be developed, we first had to identify the strengths and weaknesses mainly focusing on project management. We also wanted to get an overview of the problems project managers have to face in industrial software projects contributing to schedule and budget overruns as well as to software systems with poor quality. Thus, at the very beginning a project management assessment was performed using on-site interviews with software project managers. The results of this first case study have been summarized in an assessment report (Lichter et al., 1996). To verify the qualitative data collected during the assessment a second investigation was performed by measuring quantitative data of a software development project. Based on the results of both studies we are currently implementing a process improvement program mainly focusing on project management aspects. The key elements of this program will be presented.

Description Of The Case Studies

The First Case Study: A Project Management Assessment

At first we conducted a study whose purpose was to assess and better understand the current practices and problems of software project management as well as how they impact software development projects. The investigation was performed by means of structured, on-site interviews with software project managers. The questionnaire used for these interviews covers more than 70 factors potentially influencing the process and outcomes of software projects The questions mainly address human factors and organizational aspects. In case the interviewed project managers had managed more than one software project, they were asked to answer the questions for each of these software projects. Thus, the project managers could supply all the information they had acquired. But it became apparent that the same project manager answered most of the questions identically for every project he had managed. The data in the following sections describe the kinds of information we collected.

Project Profile

This aspect comprises characteristic attributes of software development projects. This includes attributes such as project kind, project nature, project scope, project class, and project type. Furthermore we recorded items such as the organization structures used on the project, project duration, and the application domain. Project Environment For this aspect it had to be analyzed in which way the project environment had affected the course of the project and in particular project management activities. In our investigation we considered the following environmental factors: senior management, users, customers, and subcontractors. Some of the topics we explored concerning environmental issues include:

- Goals or constraints levied against the software project by senior management, customer or user demands, e.g. schedule and/or budget constraints, staffing constraints
- User experience and participation during the project
- Prototyping method
- Customer involvement during the project
- Stability of requirements
- Agreement or disagreement on project goals
- Influence of customers, users, and senior management on the progress of the software development project
- Use of external personnel on the project
- Organization of distributed software development

Project Management

To assess the strengths and weaknesses of project management we measured the following variables:

- Project management experience
- Time and effort spent by the project manager for management activities
- Methods and tools used for project planning
- Methods applied for project control

- Responsibilities for project management activities
- Quality assurance function and staffing

Project Staff

Since project staff skill mainly influences the software development project, we collected information on the qualification of team members, experience in the application area, experience with the programming language, experience with methods and tools, and experience with the development hardware used in the project. Furthermore we recorded data on personnel management capabilities such as staff availability, training of team members, effort spent for communication, and team continuity

SUMMARY

- A computer is a general-purpose electronic counting device used in data processing because of its accuracy and high speed. The physical components of a computer system are called the hardware, which includes the central processing unit and peripheral equipment for data input, output, and storage.
- System software is the set of instructions that facilitate hardware use and allow the application software, which solves specific user problems, to run efficiently. System and application software is written by using various machine and symbolic languages.
- Computer hardware is a collection of several components working together. Some parts are essential and others are added advantages.
- System software is a set of one or more programs designed to control the operation and extend the processing capability of a computer system.
- Application software is a set of one or more programs designed to solve a specific problem, or do a specific task.
- A debugger or debugging tool is a computer program that is used to test and debug other programs (the "target" program).
- An interpreter normally means a computer program that executes, i.e. performs, instructions written in a programming language.
- Programming software usually provides tools to assist a programmer in writing computer programs, and software using different programming languages in a more convenient way.
- Open source software (OSS) is computer software that has its underlying 'source-code' made available under a license.

KNOWLEDGE CHECK

1. What's the best way to protect your hard drive data?

a. regular backups
b. periodically defrag it
c. run chkdsk at least once a week
d. run scandisk at least once a week
e. run a regular diagnostic

2. On a dot matrix printer, you should never lubricate which part?

a. carriage rails
b. printhead pins
c. paper advance bearings
d. carriage bearings
e. None of the above

3. How many devices can be used on a single SCSI bus? Keep in mind that the SCSI host adapter counts as a device.

a. 1
b. 8
c. 20
d. 10
e. All of the above

4. Match the device driver HIMEM.SYS to its operation.

a. Supports (ANSI) terminal emulation
b. Manages the use of extended memory
c. Uses expanded memory on a 80386 processor
d. Supports code page switching
e. None of the above

5. _____ help prevent power surges.

a. Surge suppressor
b. Spike protector
c. UPS system
d. High-grade multi-meter
e. `None of the above

6. A computer's type, processor, and operating system define its
   a. brand
   b. size
   c. platform
   d. speed
   e. none of these

7. What does SSE stand for in Intel's SSE Technology?
   a. Sophisticated Software Enhancer
   b. Streaming Simmd Extensions
   c. Some Stupid Enhancer
   d. Simplistic Software Extensions
   e. None of these

8. When you save the following the data would remain intact even after turning off computer?
   a. RAM
   b. Motherboard
   c. Secondary and Storage Device
   d. Primary Storage Device
   e. None of these

REVIEW QUESTIONS

1. Define the basics of software.
2. Differentiate the relationship between hardware and software.
3. Explain the steps of software development.
4. Differentiate between system and application software.
5. Describe the uses of open source software?
6. Give detailed overview about integrated development environment?
7. Briefly explain the debuggers and interpreters.

Check Your Result

1. (a)	2. (b)	3. (b)	4. (b)	5. (a)
6. (d)	7. (b)	8. (c)		

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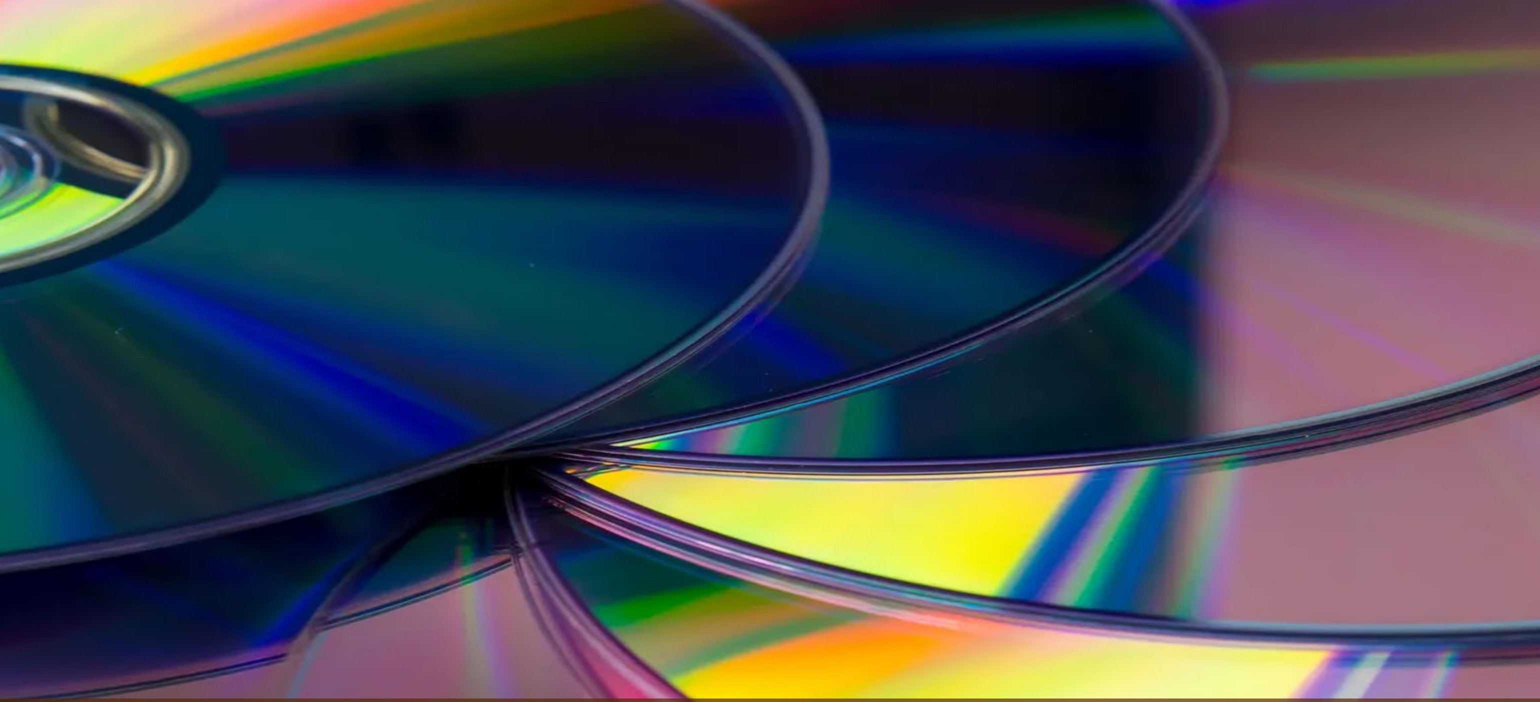


CHAPTER 3

REMOVABLE AND CD MEDIA

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Identifying, installing and troubleshooting floppy drives
2. Understand the CD media
3 Prepare for installing an optical drive guide

"The CD, it should be noted, was born out of greed. It was devised to prop up record sales on the expectation of people replenishing their record collections with CDs of albums they had already purchased."

—John Mellencamp

INTRODUCTION

Removable media introduces the capability to transfer and store huge volumes of sensitive information as well as the ability to import malicious content. Removable media is very easily lost, which could result in the compromise of large volumes of sensitive information stored on it. Some media types will retain information even after user deletion, placing information at risk where the media is used between systems (or when the media is disposed of).

Removable media is a type of storage device that can be removed from a computer whilst the system is running. Examples include:

- USB memory sticks
- External hard drives
- CDs
- DVDs
- Mobile phones and tablet devices

Removable media are data storage devices capable of computer system removal without powering off the system. Removable media devices are used for backup, storage or transportation of data. Portable device that can be connected to an information system (IS), computer, or network to provide data storage. These devices interface with the IS through processing chips and may load driver software, presenting a greater security risk to the IS than non-device media, such as optical discs or flash memory cards. Note: Examples include, but are not limited to: USB flash drives, external hard drives, and external solid state disk (SSD) drives. Portable Storage Devices also include memory cards that have additional functions aside from standard data storage and encrypted data storage, such as built-in Wi-Fi connectivity and global positioning system (GPS) reception.

3.1 IDENTIFYING, INSTALLING AND TROUBLESHOOTING FLOPPY DRIVES

A floppy disk drive (FDD), or floppy drive, is a hardware device that reads data storage information. It was invented in 1967 by a team at IBM and was one of the first types of hardware storage that could read/write a portable device. FDDs are used for reading and writing on removable floppy discs. Floppy disks are now outdated, and have been replaced by other storage devices such as USB and network file transfer.

A floppy disk commonly came in three sizes, 8 inches, 5.5 inches and 3.5 inches, becoming smaller as the technology advanced. The newer, 3.5-inch version used more cutting-edge technology and held more data than previous models, while the original 8-inch floppy drive was developed to load hardware-level instructions and/or data structures called microcode into the IBM System/370 mainframe. The 8-inch flexible diskette was read-only, held 80 kilobytes of memory and was referred to as a memory disk. Eight-inch floppy drives did not connect to the motherboard, but rotated on a turntable that was run by an idler wheel.

As the floppy disk advanced to a smaller 5.5- and 3.5-inch designs, the FDD changed as well. To accommodate a smaller floppy disk, an FDD had to make aggressive changes by matching the size of the floppy disk drive opening to the size of the floppy disk for compatibility. For many years, the majority of PCs and notebooks had a floppy drive. Using a floppy disk to exchange data between PCs was a standard method for many computer technicians. The floppy disk was one of the most common ways to store adequate amounts of data outside of a computer's hard drive for personal use because they were inexpensive and easy to carry.

As technology advanced, floppy disks were finally able to read and write. By this point, FDDs had four basic components:

- Magnetic read/write heads (one or two)
- A spindle clamping device that held the disk in place as it was spinning 300 to 360 rotations per minute
- A frame with levers that opened and closed the device
- A circuit board that contained all of the electronics.

The read/write heads could read both sides of a disk, and the same head was used for reading and writing. A separate, wider head was used for erasing data to ensure that all data was erased without having to interfere with the data already on the adjacent track.

A floppy drive cable could house two drives. In a computer system, the drive at the end of the cable was drive A. When another drive was added, it was connected to the middle of the cable and was called drive B.

Floppy drives are mostly a hardware device of the past. Newer hardware devices have been introduced, including ZIP drives, CDs and USB. Today, floppy drives are usually not included on a PC, notebook or laptop.

Before Getting Started

Write down important information from the top or bottom of the floppy disk drive such as the Model Number, Serial Number, and specifications.

Ensure you are familiar with ESD and its potential dangers.

When physically installing the standard floppy disk drive, ensure the computer is powered down and unplugged.

Keyword

Floppy Drive: It is a disk storage medium composed of a disk of thin and flexible magnetic storage medium, sealed in a rectangular plastic carrier lined with fabric that removes dust particles.

Remove Existing Floppy Drive

If you are installing a floppy disk drive because of a failed floppy disk drive, first begin by disconnecting all cables from the floppy drive currently within the computer and remove the floppy drive from the system. Most systems will require that a screw or set of screws be removed before the drive can be removed. Other computers may have the **floppy drive** attached to a removable bracket that can be removed by pressing and holding tabs.

Install

Open the computer case, and because floppy disk drives do not require any special hardware, settings such as jumpers or dip switches connect the floppy drive physically to the computer either by screws or if your computer has a removable bracket attach the bracket to the floppy drive and then place the floppy into the computer.

Connect Cables

Once the new floppy drive has been connected into the computer, connect the floppy interface cable (small gray flat cable) to the back of the floppy drive. This cable has a side with a blue or red side indicating pin one. Today, most computers and computer floppy disk drives have cables that only have two connections: one for the motherboard and the other for the floppy disk drive A. If your cable only has two connections, the picture does not apply.

Once the floppy interface cable has been connected to the computer, connect the floppy power cable to the back of the floppy disk drive. This cable is a small power cable when compared to the other power cables coming from the power supply.

Setup CMOS

Once the floppy drive has been connected to the computer, place the case back onto the computer and connect the keyboard, monitor, and power to the computer.

Once connected, turn on the computer and enter CMOS setup. Verify that the floppy drive is properly setup within BIOS, most likely as a 1.44MB 3.25" Floppy A.

Troubleshooting

If additional issues are encountered during or after the installation of the floppy disk drive, refer to main floppy disk drive page for additional help and information.

3.1.1 Floppy Drive Failures

When troubleshooting floppy drive failures, there are a myriad of components that you must take into consideration as the true point of failure. These items include the following:

- Media errors
- Drive incompatibilities
- Dirty read/write heads
- Cabling or connection errors
- Floppy controller card
- Device driver errors
- Drive failure

Commonly, what seems to be a floppy drive error is not actually a drive problem but a media error. Floppy disks are susceptible to physical and magnetic corruption, giving the customer the appearance of a bad drive with "Error reading disk" or "Error writing to disk" messages. At other times, there are drive incompatibilities so that when one drive writes to a disk, another drive cannot read it. This is common, *for example*, when you copy files from one PC and try to read them on another PC that has an incompatible drive. If you encounter this type of a problem, try reading from another disk, preferably one that was written to by the suspect drive, or writing to a second disk. If the drive can perform the operation on a different disk, it probably is a media error.

Media errors can also be caused by dirty read/write heads on the floppy drive. Dirt can get into a computer through the vents used to pull in fresh air, and as such will stick to the read/write heads. Also, while floppies have less chance of getting dirty from the plastic encasement, there is still some dirt deposited on the media when it is in use by the drive. Floppy drive cleaning kits can be purchased rather cheaply at any computer store, and you should follow the manufacturer's instructions for using them.

Another thing to check for is that there is nothing stuck in the drive itself. Sometimes, people put items in the drive that do not belong there, such as the wrong type of media. Small children are also notorious for placing items into a floppy drive just as they are with VCRs. However, even though you want to believe that people would not do these types of things, you cannot take anything for granted and must check that no foreign objects have been placed into the drive.

Cabling can also lead to drive problems. If you have just installed a floppy drive and you are experiencing a problem with the drive, such as the drive light will not go out, you probably have the cable on backwards. The red stripe on the floppy cable must be connected to pin 1 on the adapter and on the drive. Also, there will be times when you think that a cable is firmly seated on the drive, or on the adapter, and it might be a hair off. This can cause communication problems between the drive and the adapter. Try pressing on both connections to see if they move at all.

If the drive is not getting power, it will not work. Sometimes the power connector is not properly seated in the power connection. You can attempt to push the power connector to see if it moves. If it does not move, and the drive still is not getting any power, then you have to replace the drive.

Communication problems between the drive and the adapter may also be caused by an improperly seated controller card. You must gently, but firmly, press down on the adapter card. If it has not moved, then you may want to check the contacts. Contacts can get dirty and may require cleaning with isopropyl alcohol. If you suspect that the contact might be defective, you can attempt to check it using a millimeter. However, if you believe that you have a problem controller card, you can test it by installing a second floppy drive. If you can successfully use the second drive, then the controller probably is not the problem.

If the problem does not fit into any of the mentioned problems, you must check for possible software problems. The device driver used by the operating system software may have become corrupt, in which case you can try reinstalling the driver. However, if the computer has been losing its **BIOS** settings from a dying CMOS battery, you have to enter the SETUP program to re-enter the settings. With newer computers, this should not be a concern as the BIOS can usually auto-detect the drive. Unfortunately, older computers require you to re-enter these settings manually.

At this point, if you are still encountering problems, then the drive itself is at fault and must be replaced. The good news is that floppy drives are relatively inexpensive items, and they only take around 15 minutes at most to replace.

Keyword

BIOS (Basic Input/output System): It 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 devices.

Problem	Solution
The drive light does not come on as part of the normal bootup sequence; drive does not appear to work	While it is possible that the new drive's LED is burned out, it is *extremely unlikely*, as the half-life of a typical LED is similar to that of plutonium. What is more likely is that you forgot to connect the power cable to the drive. Either that, or you forgot to configure your drive type in your BIOS/CMOS setup.
The drive light comes on and stays on permanently as soon as it is powered up; drive does not appear to work	While this looks like a broken floppy drive, it really means that you have attached the controller cable backwards. Reverse it and try again.

3.1.2 Troubleshooting Floppy Disk Drive Problems in Windows

If you are having problems with a floppy disk drive (such as receiving the error message "Error reading drive <X>:" or if the status of your floppy disk drive in Device Manager is listed in MS-DOS Compatibility mode), try the troubleshooting tips in the following sections.

Safe Mode

Start Windows in Safe mode and try to access the floppy disk drive. To start Windows 95 in Safe mode, restart your computer, press the F8 key when you see the "Starting Windows 95" message, and then choose Safe Mode from the Startup menu. To start Windows 98 in Safe mode, restart your computer, press and hold down the CTRL key after your computer completes the **Power On Self Test (POST)**, and then choose Safe Mode from the Startup menu.

If you can access the floppy disk drive, follow these steps:

- Use the right mouse button to click My Computer, then click Properties on the menu that appears.
- Click the Device Manager tab.
- Double-click Floppy Disk Controllers.
- Click the floppy disk controller for the drive you are having problems with, then click Properties.
- In Windows 95, click the Original Configuration (Current) check box to clear it. In Windows 98, click the Disable in This Hardware Profile check box to select it. This disables the Windows protected-mode driver for the floppy disk drive controller.
- Click OK.
- Restart Windows normally.

Keyword

Power-on self-test is a process performed by firmware or software routines immediately after a computer or other digital electronic device is powered on.

If you can access the floppy disk drive successfully after following the steps, the following conditions may be true:

- The floppy disk drive controller may not be supported in protected mode.
- There are drivers loading in the Config.sys or AUTOEXEC.BAT file that may be necessary for protected-mode access.
- There are drivers loading in the CONFIG.SYS or AUTOEXEC.BAT file that may be causing conflicts in Windows and need to be disabled.

If you still cannot access the floppy disk drive after following steps 1-7, follow these steps:

- Use the right mouse button to click My Computer, then click Properties on the menu that appears.
- Click the Device Manager tab.
- Double-click Floppy Disk Controllers.
- Click the floppy disk controller, and then click Remove to remove the controller.
- Click OK.
- In Control Panel, double-click Add New Hardware.
- Click next, and then click yes to allow Windows to detect the hardware in your computer.
- When the Add New Hardware Wizard is finished, restart the computer and try to access the floppy disk drive again.

Redetecting the floppy disk controller should resolve any addressing problems with the controller by detecting the correct address range. If the floppy disk controller is not detected correctly, there may be a problem with the floppy disk controller. If the floppy disk controller is redetected but you still cannot access the floppy disk drive, there may be a problem with the floppy disk.

Keyword

CMOS (Complementary metal–oxide–semiconductor): It is a technology for constructing integrated circuits. CMOS technology is used in microprocessors, microcontrollers, static RAM, and other digital logic circuits.

Damaged Disks

Use the following steps to check for a damaged disk:

- Use a disk utility (such as ScanDisk) to test the disk for damage.

Before you run a disk utility, please see the following article in the Microsoft Knowledge Base:

ARTICLE-ID: 120442

TITLE : Using Hard Disk Utilities with Windows 95

- Type the following command at an MS-DOS command prompt

copy drive*.* nul

where <drive> is the floppy disk drive you are having problems with. For example, if you are having problems with drive A, insert a disk you are having problems with in drive A and type the following command:

copy a:*.* nul

This command copies the files on the disk to a null device. If there is a problem copying the files, error messages appear on the screen?

CMOS Settings

Consult your computer's documentation or manufacturer to make sure that your computer's **CMOS** settings are correct.

Irwin Tape Backup

Windows 95 Setup removes the following statement from the [386Enh] section of the SYSTEM.INI file:

device=<path>\VIRWT.386

If you re-install the Irwin Tape Backup software after you install Windows 95, this statement is placed in the SYSTEM. INI file again and can cause conflicts with floppy disk access in Windows.

Device Conflicts

Keyword

CD-ROM: It is a pre-pressed optical compact disc which contains data.

Device conflicts as reported by Device Manager can cause problems reading from and writing to floppy disks. You can resolve this problem by changing or removing the resources from Device Manager that are causing the conflict. These are typically conflicts with hard drive controller cards, video cards, or COM ports.

3.2 CD MEDIA

CD-ROM and DVD are optic readable media, contrary to hard disks, floppy disks and tapes, which are magnetic. The optic storage media are read with a very thin and very precisely aimed laser beam. They supplement the magnetic media. They have clear advantages in the areas of data density and stability: Data can be packed much more densely in optic media than in magnetic media. And they have much longer life span. It is presumed that magnetic media, such as a hard disk or DAT (digital audio tape) can maintain their data for a maximum of five years. The magnetism simply fades away in time. Conversely, the life span of optic media are counted in tens of years.

Let us take a closer look at these disks, which are becoming increasingly popular for all types of information, education and entertainment. There are different types:

The Compact Disk

The **compact disk** (CD) was introduced by Philips and Sony in 1980 to replace LP records. It is a small plastic disk with a reflecting metal coating, usually aluminum. Myriads of tiny indentations are burned into this coating. These indentations contain the music in millions of bits. The CD is organized in tracks. Each track is assigned a number.

The big advantage of the CD is its high quality music reproduction and total absence of back ground noise as well as a great dynamic. During operation, the software in the drive can correct errors caused by such things as finger marks on the disk. All in all, CDs are excellent music storage media.

The CD-ROM

The CD-ROM (Read Only Memory) came as an extension of the CD in 1984. In principle, the media and the drives are the same. The difference is in the data storage organization. In a CD-ROM, the data are stored in sectors, which can be read independently - like from a hard disk.

The CD-ROM has become an important media in the PC world. It can hold 650/700 MB of data, and it is very inexpensive to produce. Today, there are three types of CD drives and DVD drives are on their way:

Drive type	Name	The drive can
CD-ROM	Compact Disk Read Only Memory	Read CD-ROM and CD-R
CD-ROM multiread	--''--	Read CD-ROM, CD-R and CD-E
CD-R	Compact Disk Recordable	Read CD-ROM and CD-R. *Write once* on special disks named CD R
CD-RW	Compact Disk ReWritable	Read CD-ROMs and CD-R. Write and re-write on special disks (CD-RW).
DVD RAM	Digital Versatile Disk Random Access Memory	Reads all CD formats. Reads DVD ROM. Reads and writes DVD disks

Let us start by look at the CD-ROM construction. To facilitate understanding, it will be easiest to compare it with other disk types, especially the hard disk. The CD-ROM is a plastic disk of 4.6" diameter.

It is placed in a CD-ROM drive, which is like a drawer in the PC cabinet:

REMEMBER

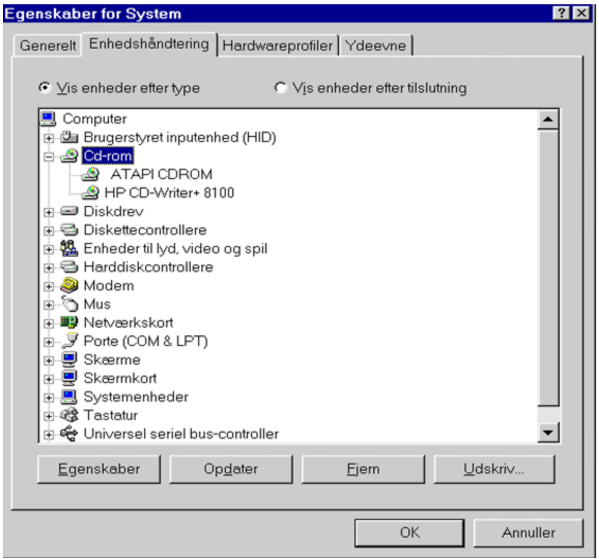
Disks are sensitive to magnetic fields and intense vibrations and should therefore be kept away from magnetic sources like cabinets with magnetic locks or lamps with metal bases.

When the CD-ROM disk is placed in the drive, it starts to spin the disk. It reaches operating speed in one to two seconds. Then the drive is ready to read from the disk.

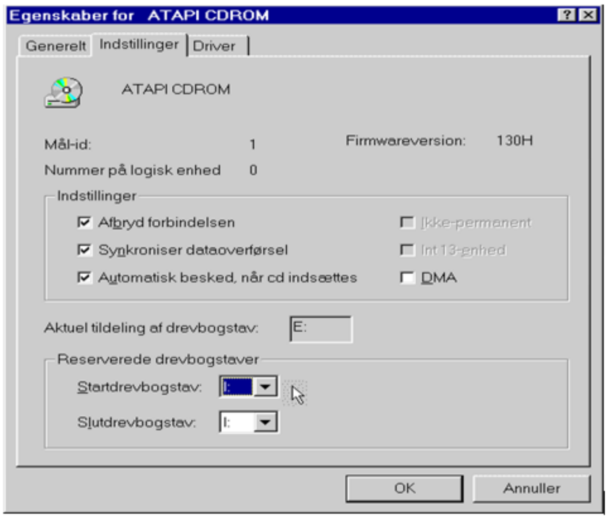
Drives and Operating System

The drive must be assigned a drive letter. That is a task for the operating system, which must be able to recognize the CD-ROM drive. That is usually no problem in Windows 95/98. However, the alphabet can be quite messy, if there are many different drives attached.

Each drive must have its own letter. They are assigned on a first come first-serve-basis. The CD-ROM drive usually gets the first vacant letter after other existing drives, typically D, E, or F. But the letter can be changed in Windows. If you hit Win+Pause, the System box opens. Find your CD-ROM drives like here (The box is Danish, but you'll find it):



Highlight the drive and choose Properties. Then you can arrange the drive letters:



Once the CD-ROM spins and the operating system (DOS or Windows) has "found" the CD-ROM drive, data can be read for processing. Now the CD-ROM works like any other drive. Only, it is Read Only Memory!

The CD-ROM holds its own file system called ISO 9660. It is not using FAT!

About Optic Data Storage

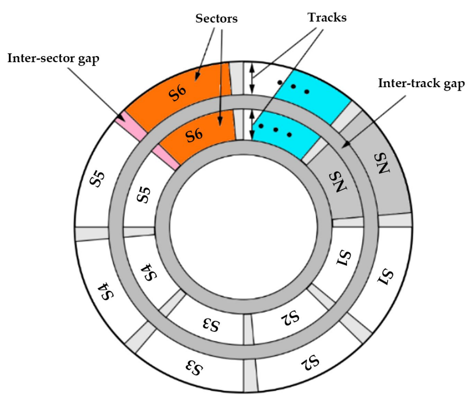
The CD-ROM can be compared to a floppy drive, because the disks are removable. It can also be compared with a hard drive, because of similar data storage capacity. Actually, a CD-ROM disk can hold up to 680 MB of data. This equals the capacity of 470 floppy disks. However, the CD-ROM is neither a floppy nor a hard disk! While floppy and hard disks are magnetic media, the CD-ROM is an optic media. The magnetic media work in principle like an audio cassette tape player. They have a read/ write head, which reads or writes magnetic impressions on the disk. The magnetic media contains myriads of microscopic magnets, which can be polarized to represent a zero or numeral one (one bit). In the optic readable CD-ROM, the data storage consists of millions of indentations burnt into the lacquer coated, light reflecting silver surface. The burnt dents reflect less light than the shiny surface. A weak laser beam is sent to the disk through a two-way mirror and the sensor registers the difference in light reflection from the burnt and shiny areas as zeros and ones.

REMEMBER

Optical storage is the storage of data on an optically readable medium. Data is recorded by making marks in a pattern that can be read back with the aid of light, usually a beam of laser light precisely focused on a spinning optical disc.

Tracks

Our data consist of bits, each of which is a burnt dent or a shiny spot on the CD-ROM disk. Music CDs are designed much in the same manner. The bits are not splashed across the disk, but arranged in a pattern along the track. Without that organization, you could not read the data. The platters in hard disks and floppies are organized in concentric tracks. There can be hundreds of those from center to periphery:



This 5 km long spiral track holds up to 650 MB data in about 5.5 billion dots (each is one bit).

Data read from CD-ROM

Data is read from the CD-ROM at a certain speed. There are two principles used reading from a CD-ROM:

CLV

Constant Linear Velocity was used in the early generations of CD-ROM drives. It implies that the data track must pass under the read head at the same rate, whether in inner or outer parts of the track. This is accomplished by varying the disk rotation speed, based on the read head's position. The closer to the center of the disk the faster the rotation speed to deliver the same constant stream of data.

CAV

Constant Angular Velocity. It is not very smart to change the rotational speed of a CD-ROM all the time, as the CLV drives do. Therefore, in more modern and speedy drives, the CD-ROM rotates at a constant number of rounds per minute. This implies that the data transfer varies; data read from the outer parts of the CD-ROM are read at very high bit rates. Data from the inner parts are read slower.

Let us look at a modern 40X CAV drive. It rotates constantly with a whopping 8900 RPM. This drive will deliver 6 MB per second when reading from the outer tracks. Reading from the inner tracks it only delivers 2.6 MB per second. An average will be 4.5 MB/sec.

Problematic Readings

The CD-ROM disk has to read in random pattern. The read head must jump frequently to different parts of the disk. You can feel that. It causes pauses in the read function. That is a disadvantage of the CD-ROM media. Also the faster drives can be rather noisy.

Within the next years the CD-ROM and DVD drives will merge into one unified drive type.

Rotation Speed and Data Transmission

There are different generations of CD-ROM drives. Here you see their data.

CD-ROM type	Data transfer rate	Revolutions per minute outermost - innermost track
1X	150 KB/sec	200 - 530
2X	300 KB/sec	400-1060
4X	600 KB/sec	800 - 2,120
8X	1.2 MB/sec	1,600 - 4,240
40X CAV	2.6 - 6 MB/sec	8,900 (constant)
40X40 multibeam	6 MB/sec	1,400 (constant)

DID YOU KNOW ?

Magnetic removable media became obsolete for the short-term in the early 1990s as optical data storage started to become practical. By 1997, the compact disk read-only memory (CD-ROM) platform became widely available as a method of optical data storage.

Personally experience no big difference between the 24X, 32X, and 40X spin drives. However, their speedy rotation of the disk causes many physical problems, and the performance vary from drive to drive and CD-ROM to CD-ROM.

When you see the rotation speeds, you wonder how much further this technology can be advanced. The hard disk can spin at higher speeds, because it operates in a sealed box. The CD-ROM does not, and the high rotation speed causes a lot of practical problems such as noise and vibrations.

Multi-beam

An interesting development in this field is the multi-beam CD-ROM drives. Instead of one laser beam, you put up seven of the kind (however, only six of them are used for data read). This TrueX/Multibeam technology from Zen Research gives 36X performance from a steady 6X CLV speed rotation. They produce a so-called 40X40-drives with 7 (6 data + 1 error correcting) laser beams, which read simultaneously. That yields genuine 40X performance with a transfer rate of up to 6MB per second, while the CD-ROM disk only rotates like a old 8X drive. Compaq also produces a drive on this basis.

Music from the CD-ROM

The PC CD-ROM drive can play regular music CDs. That is a smart “bonus”. It requires three things:

- You must have a sound card in your PC
- The CD-ROM drive must match the MPC-3 multimedia standard (all modern CD-ROM drives do)

- You must connect the CD-ROM drive to the sound card with the short special cable, which comes with the drive.

The CD-ROM can easily hold sound data, which can be played directly through the sound card - without use of the short cable mentioned. It only becomes necessary, when you want to play quality sound music. Certain games (such as Tuneland) contain both types of sound.

S/PDIF outputs

Some CD-ROM drives feature a S/PDIF (Sony/Philips Digital InterFace) output that can deliver a purely **digital signal.** This gives better sound performance and opens for new interconnectivity (i.e. with a minidisc-recorder).

Keyword

digital signal is a signal that is being used to represent data as a sequence of discrete values; at any given time it can only take on, at most, one of a finite number of values.

CD-R and CD-RW

In 1990, the CD-ROM technique was advanced to include personal burning. You could buy your own burner.

A Burner is Also a Drive

To make your own CD-ROMs, you use a drive, which can write on special CD-ROM disks.

These disks have a temperature sensing layer, which can be changed by writing. You can only write on any given part of these disks once. This CD-R disk is also called a WORM disk (Write Once Read Many). Once the CD-R is burnt, it can be read in most new CD drive – for sound or data.

Most people use CD-Recorders for:

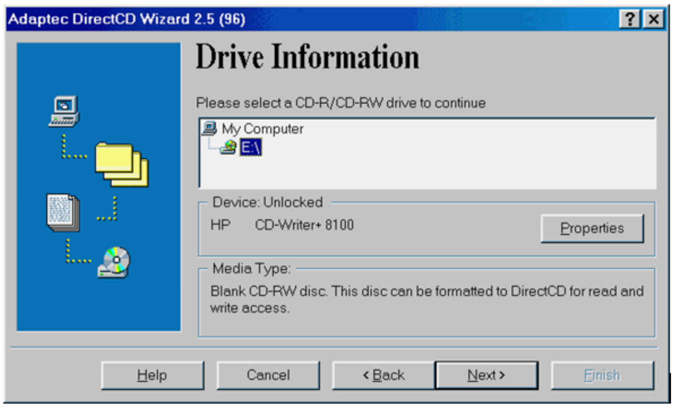
- Copying music CDs for personal use
- Backing up data (documents, images, programs)
- Producing MP3 CDs (with up to 12 hours of music)

CD-RW

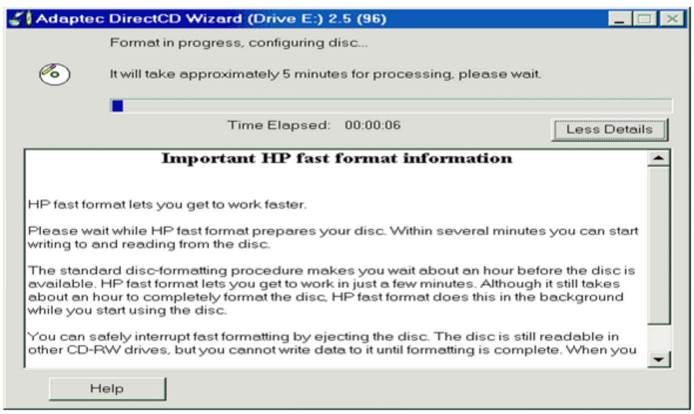
The CD-Rewritable (CD-RW) is another type of CD, where you can write multiple times on the same disk surface.

However, not all CD drives can read these CDs. New drives, which can adjust the laser beam to match the current media and hopefully read the CD-RW disks, are called multiread.

To work with CD-RW you need special software like Adaptecs. It comes with the HP 8100 drive:



You need to format the CD-RW disk before use:



The CD-R/RW on EIDE interface

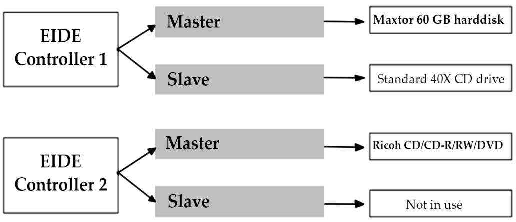
The best interface for CD-R and CD-RW drives is or used to be SCSI, but many vendors supply the cheaper and very reliable EIDE units. The leading company HP makes great IDE-based CD-RWs.

Steady Data Streaming

Burning a CD-ROM requires a very steady data streaming. Therefore the drives typically have a 2 MB cache onboard for buffer. If the buffer runs out of data during the writing process, the CD ends up unusable.

This so-called buffer under run happens quite often, especially if you process other disk-intensive work on the PC while burning a CD-ROM in a EIDE-based drive.

If you use an EIDE burner, the best is to connect it as a master unit on the secondary EIDE channel with the hard disk and CD-ROM drive on the other channel.



Burn Speed and Buffers

In 2000 the best drives selling were operating at speeds like 40x20x10x. This meens :

- CD-ROM 40X
- CD-R 20X
- CD-RW 10X

Here you see a drive called PleXWriter 12/10/32A:

It also includes a new technology called “BURN-Proof”. It should enable the recorder to pause if the Buffer-Under-Run-situation occurs. When data start rolling again, the recorder continues writing where it left.

Synchronize Data Transfer

One detail. In Windows 98/Me: Check for Settings on both CD-ROM drives. You should enable Synchronize data transfer as here:

Please do not enable DMA on your CD-ROM drives. It probably causes troubles.

3.3 INSTALLING AN OPTICAL DRIVE GUIDE

Selecting Fast, Inexpensive CD/DVD/HD DVD/BluRay Optical Drives, What to Look For in a Optical Drive, and How to Install Them

What is An Optical Drive?

To the hi-tech newcomer, the term optical drive may not mean very much. Simply put, the optical drives read (and may write) CDs; DVDs, HD DVDs; and BluRays. Virtually every modern PC contains an optical drive (either internally or externally), used as a media player, for installing new software, or as large capacity storage medium for computers.

Information is stored on high-density disks in the form of tiny pits "read" by laser. The term refers to the general category of disk drives that read information optically, using a low-powered laser. Large 12inch Pioneer LaserDiscs drives (1982) were the first optical units available on PCs, with CD-ROM drives from Sony appearing in 1983. CD-ROM drives were the breakthrough product that began as novelties for high-end users and then grew in popularity as they dropped in price and increased in performance. By The mid-1990's, the point arrived where they were mandatory equipment on any new PC system.

Optical drives are considered a part of the storage subsystem of your computer, be it a notebook, a desktop, or a server. They usually interface either through the standard IDE/ATA controller ports on the motherboard, a SCSI interface host adapter, or a dedicated adaptor card, but may also interface through a USB port or a Fire wire port, or integrated into a network storage device. The optical drive in a system is an important factor in the PC's ability to install and run software, since most software is now distributed on optical disks (CDs, and now more than ever on DVDs, in the future perhaps Blu-ray). In the case of writeable optional drives (CD or DVD Burners), they also are often the only real backup devices in the PC (as hard disks continue to increase their capacity, optical media is somewhat keeping pace).

Types of Optical Drives

CD & CD-ROM Players CD-R & CD-RW Burners
DVD & DVD-ROM Players DVD-R & DVD-RW Burners
Blu-ray Players Blu-ray Burners

Optical drives usually have a physical connection to the sound card, or audio circuits on the motherboard. Optical drives also usually send data to the system through the motherboard. When you purchase an optical drive you want to match the interface to that of the system, usually IDE/ATA or SCSI.

Today we have not just CD-ROM drives, but DVD drives, and Blu-ray drivers. We also have writeable and rewriteable CD-ROM drives, called CD-R and CD-RW respectively. These expand the capabilities of optical drives by letting you actually write to CD-ROM media.

Adding a fast optical drive will increase your PC's flexibility and life span.

What Happened To HD DVD?

In February 2008, Toshiba (the creator and promoter of HD DVD) acknowledged that it was not winning the HD media battle. Toshiba announced that it would discontinue all HD DVD player production, but that it might keep producing PC HD DVD players and burners. How long this continues is very much open at this point. Thus, while HD DVD exists in the marketplace, it is by definition a dead-end platform. Sony, for once, not only introduced a superior media (remember Betamax?), but succeeded in making it dominant. For the purposes of this article, HD DVD is really no longer recommended.

Speed How Much is Optimal?

Almost all CD/DVD burners are relatively fast. Even second-tier products can write an entire disk in less than 5 minutes. Plus, CD burning speeds are fast enough that the difference between one speed and another is not critical. In other words, if you are on a budget there is no reason to pay for a high-end DVD burner or insist on buying the fastest CD-RW drives you can find. However, speed may naturally be a benefit if you want other features.

Optical drives are normally specified with an "X" rating, intended to represent the speed of the drive.

A CD-ROM drive may be specified as "56X", or a DVD drive as "20X". This is supposed to mean that these units operate at 56 times and 20 times the speed of the first CD-ROM and DVD drives, respectively.

These "X" ratings do indicate approximate drive speed, but they have become "magic numbers" and do not really represent as much of the performance picture as you might think. Note that the CD and DVD standards are different; a 1X DVD drive actually has throughput of about eight times that of a 1X CD-ROM drive.

Speed vs. Storage

A 5 inch dual-layer DVD disk can hold 8.5 GB of data. Most stand-alone DVD players can play the dual-layer discs that these drives burn, boosting the amount of video, audio, or data that will fit on one disc. You'll pay a small price premium for early dual-layer drives, and for compatible media. Also, writing to dual-layer discs is slower than writing to single-layer, but depending on your need, may well be worth it. Generally speaking, buy the most compatible drive, with the best performance your budget will allow.

Adding an Extra Drive to an Older PC

Unfortunately, this process often requires more technology than merely plugging in the new optical drive. Your older PCs may use parallel ATA technology - 2 drives share one cable (known as a channel, and most PCs came with at least two IDE channels for a maximum of 4 drives.

So before buying a drive, investigate the computer you have to determine what you will need. It is entirely possible that the deference between buying the components you will need, and buying a new PC, may only be a couple of hundred dollars. We suggest you make a buy vs. build decision, since the new PC will probably come with a new optical drive. Or, you can upgrade the chassis & motherboard (and processor). These are all options to carefully consider.

If you go forward with the upgrade to your old PC, there are several things you will encounter. Take each step carefully, and make sure you have the 3T's (tools, time, and temperament) you need.

If you old system as a parallel ATA interface (IDE) - setting a jumper designates each drive as either a master or a slave, which permits a single cable to connect two drives to one IDE channel. The jumper settings for each designation are usually labeled on the drive itself. A few simple rules should guide your configuration choices. If possible, each drive should sit on its own IDE channel configured as a master drive, but this may not be possible because of hard disk drives in your system already configured as Master(s). If you have two drives on one channel always make the faster drive the master drive. *For example*, suppose that you wanted to add a second hard drive and a DVD burner to a PC equipped with one hard drive and one CD-RW drive. In that case, you would want to set the new, faster hard drive as master on the primary IDE channel. Your older hard drive should be the slave drive on the primary channel, with the two optical drives as master and slave on the secondary channel (keep in mind this would require re-installation of software, since the drive letters may change).

Installation: Installing your optical drives is an easy process that requires a bit of attention to detail. Here's an easy-to-follow-installation guide:

Gather up all your drives. Many cases use removable drive rails or cages to house drives. Use the included screws to attach your drives to the rails or cage, and slide them into the case. For externally accessible drives such as a DVD recorder, you can save time by installing one drive rail and sliding the drive in for a test fitting to make sure that its front is flush with the case. When the drives are installed, connect power and data cables to each one. Parallel ATA drives use wide, flat data cables that can be installed only in the correct way.

1. First, if your PC is running, shut it down and turn off the power switch.

2. Next, remove the power cord just in case – it is an important safety measure.

3. Now find and remove the screws holding the case together.
4. Next, remove the case cover or panel from your PC.

5. Find the 5.25-inch external drive cover. That is where the drive will be installed. Remove the cover.

6. Before sliding the drive into the drive bay, use the jumpers to set the drive to be either a master or slave. If the drive will reside on its own IDE cable, select the master setting. If the drive will be added to an existing IDE cable, choose slave.

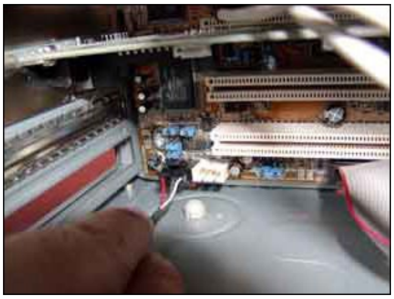
7. Note: if your drive bay requires slide rails, attach the drive rails onto the sides of the drives.

8. Next, Slide the drive into the drive bay.

9. If the case does not use drive rails, attach the drive to the bay using screws. .

10. Attach the CD-Audio cable to the connector on the drive.

11. Attach the other end of the CD-Audio cable to the motherboard or audio card.



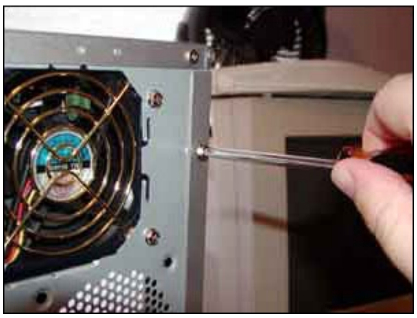
12. Next, plug the IDE cable into the motherboard, if one is not already in place.

13. Plug the drive connector of the IDE cable into the drive.

14. Attach the 4-pin power adapter in the drive.

15. Replace the case cover or panel.

16. Attach the case cover or panel with the screws.



17. Reattach the power cord to the computer.

18. Finally, turn the power switch on the power supply back on.

19. Done

Now your drive is installed (physically) into your computer. When you power up the system, it should detect the new drive. You may need to install drivers that came with the drive, and it is always a good idea to go online to see if updated drivers are available.

Solving Problems with Writeable CD and DVD Media

One of the most popular add-ons for computers (and an increasingly popular standard feature) is a writeable DVD drive. Some of the problems you might encounter with such drives include the following:

- Inability to write to the media
- Inability to read written media on another system
- Buffer underruns

Solving Cannot-Write-to-Media Problems

If your drive cannot write to writeable media, check the following issues:

- You are trying to use the wrong type of media for your drive.
- Your CD-mastering program does not support the drive.

- You are trying to use media that has been closed (write-protected).
- You are not running packet-writing (drag-and-drop) software.
- You have not formatted your media for packet-writing (drag-and-drop) file copying.
- Your drive is damaged.
- Windows XP does not support your writeable drive.

Troubleshooting Incorrect Media and Media Usage Problems

There are more types of writeable media at your local electronics and computer store than ever before, which means that the chances are increasing that you could buy the wrong type of media for your drive or for the task you want to perform.

If you have a CD-RW drive, you can use the following:

- CD-R media—CD-R media is designed to be used with CD-mastering programs; you can write to it and add files to no closed media, but you cannot delete files from it. Some packet-writing programs can also use it for drag-and-drop file copying. CD-R media has a colored recording surface that might appear gold, light green, or light blue, depending on the reflective surface and dye layer.
- CD-RW media—CD-RW media is designed to be used with packet-writing programs. Like conventional removable-media drives (USB flash, floppy, Zip, Super Disk, and others), you can erase CD-RW media and use it again. CD-RW media's recordable surface looks like a mirror.

Both types of media are single-sided; you can write on the printed surface with soft-tip markers.

Both CD-R and CD-RW media are speed rated. If you use slower CD-R media with a faster drive, you can reduce the write speed of the drive or you can try to write at top speed and then try the completed media on other drives to see if it is readable. However, CD-RW media is sold in four speed ranges, and you cannot cheat when you use it. High-speed CD-RW media (4-12x) can be used only in CD-RW drives with rewrite speeds of 4x or faster. If you want to transfer data stored on CD-RW media from a 12x drive to a drive with the slower 2x rewrite speed, you must use standard speed (2x/4x) CD-RW media in your fast drive. CD-RW media is also available in Ultra Speed, supporting rewrite speeds from 16x to 24x, and Ultra Speed Plus, supporting rewrite speeds of 32x.

For Easy Reading, Stick to CD-R

If you are not sure what type of optical drive will be used to read your information, play it safe: Burn a CD and close it (finalize it). CD-RW media is great for making backup copies of your own work in progress, but with four speed ranges, you can have problems reading fast media in older, slower drives. DVD drives are increasingly common, but with different media standards, it can be hard to choose a media type that works with every DVD drive. Fortunately, both CD and DVD drives can read CD-R. Therefore, to make sure everybody can read your stuff, use CD-R!

A number of manufacturers now make various types of writeable DVD drives. There are actually at least seven types of writeable DVD media, and because many drives can use only one or two types, it is essential that you buy the correct type(s) for your drive:

- DVD-RAM—A rewriteable/erasable media similar to CD-RW, but can be single- or double-sided. DVD-RAM is usually kept in a closed disc caddy to protect its surfaces. Very few drives use DVD-RAM.
- DVD-R—A writeable/non-erasable media similar to CD-R; some DVD-RAM and all DVD-RW drives can use DVD-R media.
- DVD-RW—A single-sided rewriteable/erasable media similar to CD-RW. DVD-RW drives can also write to DVD-R media.
- DVD+RW—A rewriteable/erasable media. Also similar to CD-RW, but not interchangeable with DVD-RW or DVD-RAM.
- DVD+R—A writeable/non-erasable media. Also similar to CD-R, but not interchangeable with DVD-R.
- DVD+R DL—The first dual-layer DVD media. Stores up to 8.5GB.
- DVD-R DL—A dual-layer version of DVD-R. Stores up to 8.5GB.

Keyword

Firmware is a specific class of computer software that provides the low-level control for a device's specific hardware.

DVD media is speed rated. You can use media rated for high-speed (8x and faster) drives with older drives with no problems. However, some early DVD-RW and DVD+RW drives need firmware upgrades to use 2x or faster (DVD-R/RW) or 4x or faster (DVD+R/RW) media safely; drives using old **firmware** can be damaged by trying to write to faster media. If you are using a first- or second-generation DVD rewritable drive, make sure your drive can use today's media! Install the latest firmware made for your drive.

Most DVD+RW and DVD-RW drives, along with some DVD-RAM drives, can also use CD-RW and CD-R media. Most drives today support both – and + media.

All rewritable media (CD-RW, DVD-RAM, DVD-RW, and DVD+RW) must be formatted before it can be used for drag-and-drop file copying. Depending on the media type, this process can take as much as a half-hour or longer.

The latest rewritable DVD drives can use DVD+R DL media, and some can also use DVD-R DL media. Keep in mind that most single-layer rewritable DVD drives, even with firmware updates, cannot read DL media. If you write DL media and read it in your DL-compatible drive, but another DVD drive prompts you to insert a disc after you insert the DL media, the DVD drive cannot read the DL media. Check with the vendor of both the DL drive and the target DVD drive for firmware updates.Although CD-mastering programs can also use rewriteable media, you should not use such media with these programs because the media might not be erasable after being mastered. Use CD-R, DVD-R, or DVD+R media for CD- or DVD-mastering tasks.

Troubleshooting CD-Mastering Drive Support Problems

Originally, the only way to write to CD-R media was with a mastering program such as Roxio Easy Media Creator (originally developed by Adaptec) or Nero Burning ROM. These and similar programs typically feature a Windows Explorer–style interface that you use to create a list of files and folders you want to write to a CD. Unfortunately, if your particular brand and model of writeable drive is not supported by the mastering program you want to use, you cannot use the program to write to your media.

Here are some indications your mastering program does not work with your drive:

- The program does not detect your drive at all.
- The program does not list your drive as a target drive for writing files.
- The program detects your drive, but displays an error message when you try to write files to the drive.

To solve problems like these, try the following:

- Before you install a new CD or DVD recording program, check the vendor's website for compatibility with your drive.
- Download the latest CD and DVD recorder support files from the vendor's website. Most vendors provide a database of supported recorders and software versions you can query. If your recorder appears on the list of supported recorders, but the version of software listed is more recent than the one you use, download the recommended update. Keep checking the software vendor's website for further updates if your recorder is not listed yet.

- Upgrade to the latest version of your preferred software. If you use a no-longer current version of CD-mastering software and your recorder is not listed as supported, see if the latest version will support it and purchase the upgrade if a free update is not available.
- Use the recording software provided with the drive instead of a third-party product. Although many writeable drives come with bare-bones software that might lack some of the features of a commercial product, the program packaged with the drive will work.
- Change to a different brand of software.

Troubleshooting Problems with Closed Media

All but the earliest CD-ROM drives are designed to read media that can be added to (multiple session) or media that has been closed (write-protected).

If your CD-mastering program displays an error message indicating that you need to insert media that has enough room for the files you want to write, and the media has more than enough space, the media was closed when it was created and no more files can be placed on the media. You can determine how much space is used on a writeable CD with Windows Explorer/My Computer. Right-click the drive and select Properties to see the amount of space used: 74-minute media can hold about 650MB, whereas 80-minute media can hold about 700MB of information. Single-layer DVD media can hold about 4.5GB of information, whereas dual-layer DVD media can hold over 8GB of information. The properties sheet for the drive will also say the media has 0 bytes free, but this is misleading. Most mastering programs will also list the amount of space used by the files you want to transfer to CD or DVD.If you want to write files to the media more than once, be sure that you select the option that does not close (finalize) the CD or DVD when you create it some programs choose this option for you by default, whereas others might close (finalize) the CD unless you choose otherwise.

Troubleshooting Drag-and-Drop (Packet-Writing) Problems

CD or DVD mastering is an excellent way to copy a large number of files to a CD or DVD all at once, but it is not designed to allow files to be dragged from their original location and dropped (copied) to a CD or DVD. Hence, most CD- and DVD-mastering programs come with separate packet-writing programs to allow drag-and-drop file copying. For example, older versions of Easy CD Creator included DirectCD, newer versions (including the latest Easy Media Creator) include Drag-to-Disc, and Nero Burning ROM comes with InCD (or you can download a copy if your version of Nero did not include it). Packet-writing software writes files that correspond to a standard called Universal Disk Format (UDF).

Floppy disks, Zip disks, Super Disk (LS-120/LS-240), and other types of magnetic removable-media storage are preformatted; you can copy files to them as soon as you insert them into the drive. However, optical media must be formatted before you can use it for drag-and-drop copying.

The packet-writing software supplied with your drive (or as part of a CD- or DVD-creation program you bought at the store) is used to perform this task.

You should provide a label (descriptive name) for your media to make it easy to distinguish among different CD-RW or rewritable DVD discs (the label is displayed in Windows Explorer/My Computer). Use compression to save space.

If you are unable to start the formatting process, check the following:

- If you have another writeable drive installed, close any resident software used by the other drive (check the system tray). You should use only one UDF writing program.
- Use the correct type of media for your recorder and packet-writing program.
- If you use rewritable DVD media, use DVD+RW media if your drive supports this type. DVD+RW media is formatted as you work after just a brief preparation process. DVD-RW media takes much longer to format.

Drives that rewrite at 10x or faster can use 4x–12x media, but drives that rewrite at only 4x cannot use faster media. If your packet-writing program does not support CD-R media, you must use rewritable media.

If the drive reports an error during the formatting process, try another CD-RW or rewritable disc and retry the process. If the problem repeats itself, contact the drive vendor for help.

When you insert the media into your drive for copying files, make sure the packet-writing program recognizes the media before you try to use it.

When you want to remove the media, use the Eject command built into your packet-writing software to close the media so it can be read. Unlike closing the media on a CD-R-mastering program, closing CD-RW or rewritable DVD media does not prevent reuse of the media by the packet-writing program. By default, the media is closed so it can be read on any CD-ROM or DVD-ROM drive equipped with compatible UDF (Universal Disk Format) reading software (some programs, such as DirectCD, copy the reader to the media for you) and by other CD-RW drives.

If you are unable to read a CD-RW disc on another drive, check the following:

- The drive must be MultiRead or MultiRead2 compliant. Almost all CD-ROM drives that are 24x or faster are MultiRead compliant, and most recent DVD drives are MultiRead2 compliant (MultiRead/MultiRead2 drives use different types of lasers to read rewriteable media because it has lower reflectivity than ordinary pressed or CD-R media).
- Return the media to the original computer and use the packet-writing program's Eject feature to properly close the media.
- Install a UDF reader program compatible with the media. If the media didnot include such a reader, download one from the CD-mastering program's vendor.

DID YOU KNOW ?

UDF shares the basic volume descriptor format with ISO 9660. A "UDF Bridge" format is defined since 1.50 so that a disc can also contain a ISO 9660 file system making references to files on the UDF part.

Troubleshooting Problems with the Writeable Drive Hardware

If writeable drive has any of the following symptoms, it might be defective and need to be serviced:

- You must remove and insert media a couple of times before the packet-writing or mastering program will recognize it.
- Your drive is no longer recognized as a writeable drive by your mastering or packet-writing program.
- Your drive is not displayed in My Computer or Windows Explorer.
- Your drive ejects and retracts its media tray when you did not press the Eject button or use the Eject option in your software.
- A CD or DVD shattered inside the drive.

Before you contact your vendor for help, try the following:

- Review the troubleshooting sections earlier in this chapter for the drive interface your writeable CD uses. Most internal drives are ATA/IDE, whereas external drives usually connect to the USB or IEEE-1394 ports.
- Check the settings for the drive in Device Manager. Check the vendor's documentation for the correct DMA setting (Enable or Disable). If the drive's settings tab indicates the drive is not using DMA and the drive manufacturer recommends it, enable it. If DMA is already enabled, disable it (the drive will create CDs more slowly).
- Install the latest bus-mastering drivers available for your motherboard's chipset. Check your system or motherboard vendor's website for details and files to download.
- Check the data cable and make sure it is tightly connected to both the drive and the host adapter. Replace a defective cable.
- Use an 80-wire UDMA cable instead of a 40-wire cable on an ATA/IDE drive. You might need to change the jumpering from Master/Slave to Cable Select.
- Download the latest drivers for your writeable drive and the latest software updates for your CD-mastering and packet-writing programs.

See "Configuring

- ATA/IDE Drive Jumpers,".
- Check with the drive vendor for a list of recommended media. Substandard media or media that uses a different dye layer than what the drive is optimized for can cause major problems with reliable writing.

Troubleshooting Problems with Windows XP and Writeable Drives

Some vendors of computers running Windows XP have not included any CD-mastering software with systems that include CD-RW drives. Yet, it is possible to create CDs with these computers without buying any software. Should you?

Windows XP supports writeable drives. Badly. Instead of providing CD-mastering and packet-writing software, Windows XP uses a very slow and inefficient way of copying files to a CD-R or CD-RW disc. The process works this way:

- Select the files you want to transfer to the writeable drive in My Computer.
- Select Copy the Selected Items and then select the writeable drive as the destination. The files are copied to a temporary folder.
- Click the CD icon in the system tray to view the files waiting to be copied to the CD

CASE STUDY

STATE OF CONNECTICUT V. JOHN KAMINSKI

In 2004, John Kaminski was interrogated by the New Britain, Connecticut, police following a complaint about his alleged sexual abuse of a 14-year-old girl. After obtaining a search warrant of Kaminski's home, police confiscated his computer, his digital camera, and a number of compact discs. It quickly became obvious that Kaminski had erased a considerable amount of evidence from his computer's hard drive, as well as the compact discs that had been seized. The suspect had run a quick erase on the CD-RW disc. In this particular case, investigators were able to create a new compact disc and retrieve the evidence from the suspect's CD-RW. Adaptec's CD Creator was used to begin the burn process to create a new session on the disc's lead-in. The burn process was then aborted right after the table of contents (TOC) was created. With a new session created, the evidence on the CD-RW could then be read. Obviously, no experimentation was conducted directly on the suspect's disc. A copy of the disc would be used in the reassembly process.

It is important to know that, in this case and many other cases, extensive scientific testing was conducted to ensure that the CD burn process to make the CD-RW data recognizable did not affect any other data stored on the CD. Conducting tests to demonstrate consistent results is extremely important to ensure that evidence will stand up to any objections by a defense attorney.

In this particular case, the reassembled CD-RW contained six videos of Kaminski sexually abusing and torturing three children who had been drugged. Faced with this evidence, Kaminski accepted a plea bargain and was sentenced to 50 years in prison.

SUMMARY

- Removable media introduces the capability to transfer and store huge volumes of sensitive information as well as the ability to import malicious content. Removable media is very easily lost, which could result in the compromise of large volumes of sensitive information stored on it
- Removable media are data storage devices capable of computer system removal without powering off the system. Removable media devices are used for backup, storage or transportation of data. Portable device that can be connected to an information system (IS), computer, or network to provide data storage.
- Portable Storage Devices also include memory cards that have additional functions aside from standard data storage and encrypted data storage, such as built-in Wi-Fi connectivity and global positioning system (GPS) reception.
- The floppy disk was one of the most common ways to store adequate amounts of data outside of a computer's hard drive for personal use because they were inexpensive and easy to carry.
- Device conflicts as reported by Device Manager can cause problems reading from and writing to floppy disks. You can resolve this problem by changing or removing the resources from Device Manager that are causing the conflict.
- The optic storage media are read with a very thin and very precisely aimed laser beam. They supplement the magnetic media.
- The CD-ROM (Read Only Memory) came as an extension of the CD in 1984. In principle, the media and the drives are the same. The difference is in the data storage organization.

KNOWLEDGE CHECK

1. **UDF stands for**
   a. Undated disk format
   b. Universal data frequency
   c. Unique disk format
   d. Universal disk format
2. **____________has smallest storage capacity**
   a. Floppy disk
   b. Zip disk
   c. Hard disk
   d. CD
3. **The storage device that uses rigid, permanently installed magnetic disks to store data is**
   a. Floppy
   b. Permanent disk
   c. Optical disk
   d. Hard disk
4. **The type of device which is 3 ½ inch floppy drive is nothing but**
   a. Storage
   b. Input
   c. Output
   d. Software
5. **What is the program required for writing to CD-RWs called?**
   a. LDE packet writer
   b. CDF packet writer
   c. VDF packet writer
   d. BDF packet writer
6. **The transfer rate, when the USB is operating in low-speed of operation is _____**
   a. 5 Mb/s
   b. 12 Mb/s
   c. 2.5 Mb/s
   d. 1.5 Mb/s

7. The high speed mode of operation of the USB was introduced by _____

a. ISA

b. USB 3.0

c. USB 2.0

d. ANSI

8. The sampling process in speaker output is a ________ process.

a. Asynchronous

b. Synchronous

c. Isochronous

d. None of the mentioned

REVIEW QUESTIONS

1. Manage remaining ques. in 1 to 5 formate.
2. How can you find the reason behind floppy drive failures?
3. Explain the troubleshooting floppy disk drive problems in windows.
4. Define the use of CD media.
5. Define the synchronize data transfer.
6. Elaborate the features of HD DVD.

Check Your Result

1. (d) 2. (a) 3. (d) 4. (a) 5. (c)

6. (d) 7. (c) 8. (c)

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CHAPTER 4

HARD DRIVE

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Discuss the partitions and file systems
2. Define installing a hard drive
3. Explain the formatting and partitioning a hard drive
4. Describe the basic troubleshooting techniques
5. Discuss scandisk and defrag

"A disk unbeknownst to the director can go to the producer in another city or in another office and that producer can edit behind the director's back much easier than in the old days. Since these dailies are now put on videotape, more kinds of people have access to dailies."

—John Frankenheimer

INTRODUCTION

A hard drive is a piece of hardware used to store digital content and data on computers. Every computer has an internal hard drive, but you can also get external hard drives that can be used to expand the storage of a computer. cHard disk drives are made up of magnetized disks—known as platters—that spin rapidly, typically somewhere between 5,400 and 15,000 RPM. The faster the magnetic disk rotates, the quicker your computer is able to access information from it.

All digital data comes in the form of binary code—a series of ones and zeros that can represent any piece of information. The read/write heads of a hard drive are used to input these ones and zeros by magnetizing portions of the platter. Each tiny portion of the platter houses a bit, which will be equal to either 1 or 0. The head can detect the magnetism of each portion, thus "reading" information from it. The same head that can "read" data can also "write" it, by changing the magnetization of bits on a platter.

Any time a change is made—such as a new file being saved or a file being deleted—the head of the hard drive will adjust the magnetism of the platter accordingly. You can picture it like a record player, with the vinyl disk being the platter containing the information, and the arm being the heads that scan that information.

Because data is stored magnetically, HDDs are non-volatile devices, meaning that they retain data even when the computer is turned off.

These days, internal HDDs can reach a maximum capacity of 20 TB. Since the emergence of SSD, hard disk drives are rarely used as a computer's secondary storage, but are still reliable as an external storage option.

Keyword

Partition: It is a logical division of a hard disk created so that you can have different operating systems on the same hard disk or to create the appearance of having separate hard drives for file management, multiple users, or other purposes.

4.1 PARTITIONS AND FILE SYSTEMS

A computer requires an operating system to allow users to interact with and use it. The operating system interprets keyboard and mouse movements and allows for the use of software, like an Internet browser, word processor, and video games. To install a computer operating system, a hard drive (or another storage device) is required. The storage device provides the storage medium where the operating system is installed and stored.

A hard drive is also required for the installation of any programs or other files you want to keep on your computer. When downloading files to your computer, they are permanently stored on your hard drive or another storage medium until they are moved or uninstalled

When a hard drive is installed in a computer, it must be partitioned before you can format and use it. Partitioning a drive is when you divide the total storage of a drive into different pieces. These pieces are called partitions. Once a partition is created, it can then be formatted so that it can be used on a computer. When partitions are made, you specify the total amount of storage that you would like to allocate to that **partition** from the total size of the drive.

Why make partitions

Now that you know what a partition is, you may be wondering why you would even need to make multiple partitions instead of just making one. Though there are quite a few reasons, we will touch on some of the more important ones below:

- ***Multiple File systems***: When you create a partition, you then need to format it before it can be used. When formatting a partition you tell the operating system what file system you would like that partition to be formatted in. Once you format a partition, and therefore assign the type of file system you want to use with it, you cannot change that file system without formatting the partition again and losing all the data contained on it. If you require different file systems on your computer, whether it be for security or for a specific application, you can then make multiple partition and assign one type of file system to one of the partitions and another to one of the other partitions.

If you have an 80 GB drive, then it would be possible to make one partition consisting of the entire 80 GB of available storage. Alternatively, you could make two partitions consisting of a 20 GB partition that will be used for the operating system and programs and a 60 GB partition set aside for data, music, and images.

- ***Partition Size***: On older operating systems the maximum size of a partition was limited. Therefore if you had more storage space on a hard drive than was usable in a single partition, you would need to create other partitions to utilize this unused space.
- ***Multiple Operating Systems***: Some operating systems use file systems that are not compatible with other operating systems. If you want to use two operating

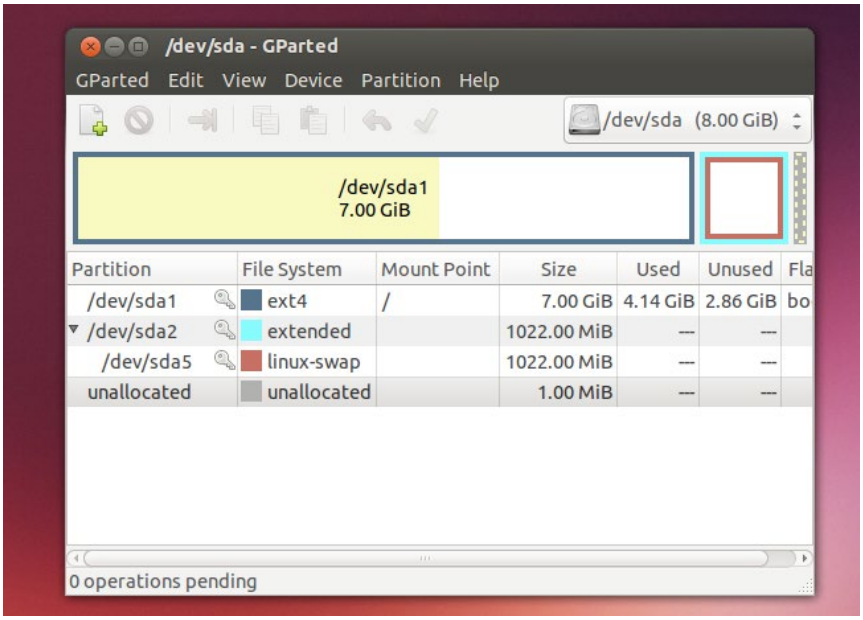
systems on the same computer that are not compatible in this way, you could then make two partitions, one for each operating system. Then a boot loader could be used to switch between them when you start your computer.

- ***Wasted disk Space***: When a file systems store data in a partition, the larger the partition, the greater the chance of wasted space. By having multiple partitions of smaller size, you reduce the amount of waste that file systems may create.
- ***Separate system files from users' files***: Some components of an operating system require storage space to operate. For example, in Windows if you have no hard drive space available on the drive that Windows is installed on, you will not be able to print. By creating a partition solely devoted to the operating system and then another partition dedicated to your own data and programs, there is less of a chance of you using up the space on the operating system partition with your data, and thus not causing problems.

4.1.1 Primary, Extended, and Logical Partitions

When partitioning, you will need to be aware of the difference between primary, extended, and logical partitions. A disk with a traditional partition table can only have up to four partitions. Extended and logical partitions are a way to get around this limitation.

Each disk can have up to four primary partitions or three primary partitions and an extended partition. If you need four partitions or less, you can just create them as primary partitions.



However, let us say you want six partitions on a single drive. You would have to create three primary partitions as well as an extended partition.

The extended partition effectively functions as a container that allows you to create a larger amount of logical partitions. So, if you needed six partitions, you would create three primary partitions, an extended partition, and then three logical partitions inside the extended partition.

You could also just create a single primary partition, an extended partition, and five logical partitions; you just cannot have more than four primary partitions at a time.

How to Partition

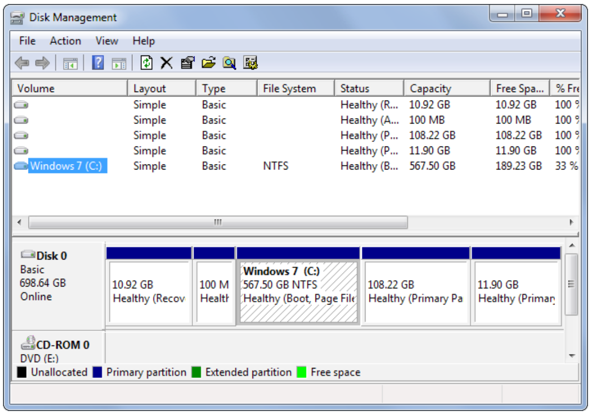
Partitioning with graphical tools is fairly easy if you know what you're doing. While installing an operating system — Windows or Linux — your operating system installer will offer a partitioning screen where you can create, delete, format, and resize partitions. (Note that deleting or formatting a partition will erase all the data on it!)

You can also use tools like the Disk Management tool in Windows and GParted on Linux to manage partitions on your system drive or other drives.

wYou cannot always modify a partition while it is in-use. *For example*, you cannot delete a Windows system partition while you're running Windows from it! So you may need to boot from a Linux live CD or use an operating system installer disk to make many changes.

These tools allow you to partition your system drives as well as other internal drives, external drives, USB drives, SD cards, and other storage media.

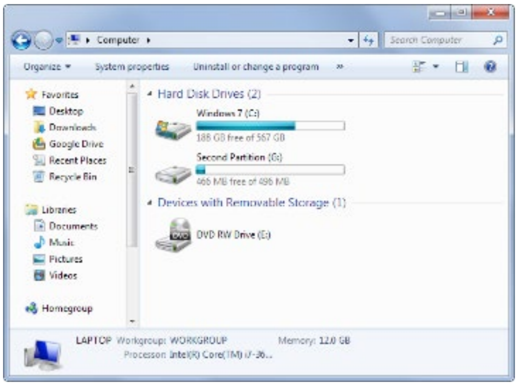
If you have a single drive with 500 GB of storage on your computer, you would have a C:\ drive with 500 GB of space available to you in Windows. But, if you partitioned that drive in half, you'd have a C:\ drive with 250 GB of space and a D:\ drive with 250 GB of space displayed in Windows Explorer.



How Partitions Appear as Disks, but do not Offer the Same Performance Benefits

Operating systems display separate partitions as separate drives.

These drives may look like separate physical devices, but they do not function that way. Although they appear as different disks, they are still the same physical piece of hardware. There is only so much speed to go around. You do not gain the performance benefits from using two separate partitions that you do from using two separate physical drives.



Most people will not have to worry about this, as drives generally come with a single partition set up, operating systems partition automatically, and so on. However, it is helpful to know how partitions work when you need to get your hands dirty.

4.1.2 File Systems

It is important to differentiate between the FAT file system and the file allocation table (FAT).

FAT is the name of the file system used by DOS operating systems (DOS and Windows 95, as well as Windows NT and OS/2 which support it).

Operating system	Associated file system
DOS	FAT16
Windows XP	NTFS
Windows 98	FAT32
Windows 95	FAT16 - FAT32 (for version OSR2)
Windows NT	NTFS
OS/2	HPFS
Linux	Linux Ext2, Linux Ext3

FAT file systems are characterized by the use of a file allocation table and clusters (or blocks). Clusters are the smallest unit of storage in a FAT file system. A cluster actually represents a fixed number of disk sectors.

The FAT (File Allocation Table) is the heart of the file system. It is located in sector 2 of cylinder 0, head 1 (and is duplicated in another sector as a precaution in the event of an accident). This table records the numbers of the clusters that are used, and where the files are located in the clusters.

Keyword

FAT: It is a table that an operating system maintains on a hard disk that provides a map of the clusters (the basic units of logical storage on a hard disk) that a file has been stored in.

The FAT file system supports disks or partitions up to a maximum size of 2 GB, but only allows at most 65536 clusters. So, whatever the size of the partition or disk, there must be enough sectors per cluster so that the entire disk space can be contained in these 65525 clusters. As a result, the larger the disk (or partition), the greater the number of sectors per cluster.

The FAT file system uses a root directory (represented on the operating systems that use this type of file system by the symbol C:\) , which must be located at a specific location on the hard drive. This root directory stores information on the sub-directories and files that it contains. For a file, it will store:

- the file name
- the file size
- the date and time the file was last modified
- the file attributes
- the cluster number at which the file starts

4.1.3 How can be Using Multiple Partitions? Explain

There are three types of partitions: primary partitions, extended partitions and logical drives. A disk may contain up to four primary partitions (only one of which can be active), or three primary partitions and one extended partition. In the extended partition, the user can create logical drives (i.e. create the impression that there are several smaller-sized hard drives).

Primary Partition

A primary partition must be logically formatted and have a file system appropriate to the operating system installed on it. If you have several primary partitions on your disk, only one will be active and visible at a time, depending on the operating system with which you started the computer. By choosing which operating to load at start-up, you determine which partition will be visible. The active partition is the partition from which one of the operating systems was loaded when the computer was started up. The partitions other than the one from which you started will then be hidden, which will prevent their data from being accessible. The data on a primary partition are therefore only accessible from the operating system installed on that partition.

REMEMBER

The hard drive is sometimes referred to as the "C drive" due to the fact that Microsoft Windows designates the "C" drive letter to the primary partition on the primary hard drive in a computer by default. While this is not a technically correct term to use, it is still common.

Extended Partition

Extended partitions were developed to overcome the limit of four primary partitions, as you can create as many logical drives as you want in them. At least one logical drive is required in an extended partition, as you cannot stored data in them directly. Many machines are formatted with one large partition using up all available space on the drive. This is not, however, the most advantageous solution in terms of performance and capacity. The solution is to create several partitions, which will allow you to:

- install several operating systems on your disk
- save disk space
- increase file security
- organize your data more easily

Let us have a look at what a system containing several operating systems looks like:

Primary partitions			extended partitions (2 logical drives)	
Active partition FAT (Dos/Windows95)	NTFS (Windows NT)	HPFS (OS/2)	Linux ext2	Linux swap

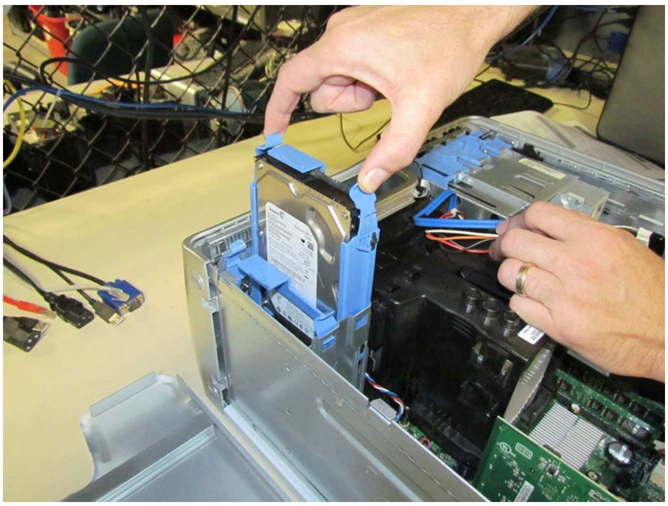
4.2 INSTALLING A HARD DRIVE

Installing an internal hard drive is one of the more straightforward upgrades out there and is often a better option than using external drives that are slower and may be dropped or misplaced.

The process usually requires no more than mounting it, connecting a couple of cables, and formatting the drive for use. Still, there are a few things you should know to make installation as smooth as possible.

4.2.1 Drive Cages, Bays and Mounting Options

Internal 3.5-inch hard disk drives are typically mounted in a drive cage or in an available drive bay. Placement and orientation of the cages or bays will vary from case to case. The most common location is at the lower front, near the intake fans and away from other components. Drive cages/bays will most often be mounted perpendicular to the bottom of the chassis, while drives mounted in the cages usually sit parallel to the bottom of the case.



In mainstream cases, drive connectors will typically point to the rear. In enthusiast-class cases, it is becoming more common to see the drive's connectors facing the right side, making it easier to route and hide cables behind the motherboard tray. Some enthusiast-class also cases give users the ability to remove drive cages or to mount them in different positions to optimize air flow and simplify **cable management.**

4.2.2 Mounting your Hard Drive

Physically mounting the hard drive in a PC is probably the most difficult part of the installation process.

Keyword

Cable management refers to management of electrical or optical cable in a cabinet or an installation. The term is used for products, workmanship or planning.

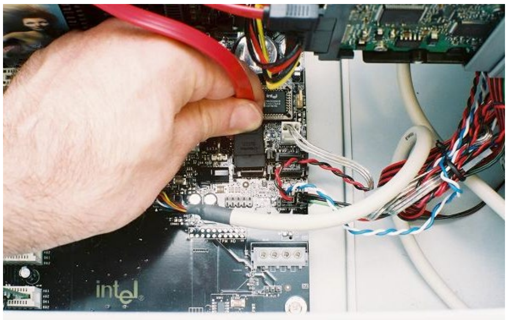
Securing the drive to a cage usually requires four screws on the sides or bottom of the drive. Many cases, especially enthusiast cases, use tool-less trays that hold the drives with simple pins and clips.

Using screws is the more robust mounting method, but tool-less trays are fine for systems that will not be moved around much.

Drives last longer when they stay nice and cool. When mounting drives in a system, try to leave as much space between them as possible to maximize airflow over the tops and bottoms. Positioning the drives directly in front of an intake fan also helps.

4.2.3 Connect the Hard Drives with SATA

Once the drive is mounted, connecting it to system is quick and easy. Virtually all new desktop hard drives sold today use the SATA interface. SATA uses simple cables that are keyed to fit on the drive and motherboard connector one way. Connect one end of the SATA cable to the drive, and the other end to an available SATA port on your motherboard, and you are halfway there.



You may find the SATA cables included with your new drive or motherboard feature different connectors: straight ends or right-angle (L-shaped). Some may have metal retention clips, while others do not. The shape of the connector makes no difference in performance.

Try to find SATA cables with metal retention clips, because they help keep the connectors secured. Newer SATA 3 (6-gigabit)-compliant cables will usually come with the clips, but older SATA 2 (3-gigabit) cables do not.

When you're done connecting the SATA cable, you'll have to connect the drive to your power supply unit (PSU). The SATA power cable from your PSU, like the SATA data cable, is keyed to fit onto the drive one-way. As long as you do not force it, there's really no way to mess it up.

Keyword

BIOS: System BIOS is a chip located on all motherboards that contain instructions and setup for how your system should boot and how it operates.

4.2.4 Configure the BIOS

Once you have mounted and connected the drive, power up your system and enter the **BIOS**/UEFI. You can usually access the BIOS/UEFI by pressing the DEL or F2 keys right after powering up the system. Usually, your system will display a message along the lines of “Press DEL to enter Setup.” Consult your motherboard’s manual for the correct key.

In the BIOS, go to the standard System Settings menu or the Integrated Peripherals > SATA menu to see all of the drives installed in the system. If all of your drive controllers are enabled and the drive is properly connected (and functional), it should be listed in the BIOS.

If the drive is not listed, shut down our PC. Double-check all of the connections, boot into the BIOS and check again. If the drive still is not showing up and all the connections are secure, try plugging the SATA data cable into a different port on the motherboard. To confirm that Windows recognizes the drive, open up Device Manager. In Windows 8, right-click the Windows button on your desktop and select Device Manager. Check for the drive in the Disk Drives section. When you boot into Windows after installing the drive, you may see the New Hardware Found wizard pop up if the drive is detected.

4.3 FORMATTING AND PARTITIONING A HARD DRIVE

Hard drive space will always be in constant demand, what with the average game install exceeding a gigabyte of space, and fast Internet and file sharing conspiring to fill our computers with things we cannot possibly do without. Fortunately, hard disk space continues to expand affordably. As the average computer can use up to three hard disks in addition to a CD drive, it is easy enough to go out and buy a new drive to add extra storage space to your system. Easy enough until you get around to actually putting the drive in, that is. Few other computer upgrades carry more potential complications and complexities than installing and preparing a newly purchased hard drive for use.

We will cover all the necessary steps for installing and preparing a second hard disk drive on both Win9x/ME and Win2K/XP systems, as well as setting up the hard drive for installation on a brand new computer with no operating system. As both IDE and Serial ATA hard drives are used in modern PCs

There are a few words we need to define before going any further:

- ***Partition, partitioning***: Free space on a hard disk must be partitioned before it can be used by an operating system. Creating a partition reserves a physical portion of the hard drive space for use as a logical drive, or volume, that the operating system can address.

- ***Volume***: A volume is how the operating system 'sees' your free disk space. Volumes (also called logical drives) are represented in Windows by drive letters such as C:, E:, etc. Volumes are formed by partitioning the free space of a hard drive. Volumes must be formatted with a file system before data can be stored on them.
- ***Formatting***: Formatting is the act of creating a file system on a volume, so that the operating system can store and retrieve data on that volume.
- ***File system***: A file system provides a means of organizing and retrieving information written to a hard disk or any other storage medium. A file system is created on a volume when it is formatted. Common Windows file systems include FAT32 (File Allocation Table 32) and NTFS (NT File System).

4.3.1 How to format a hard drive in Windows (Vista, 7 or 8)

There are many reasons why you might want to format a hard drive, including a clean installation of Windows, to get rid of a virus or malware or simply because you are giving the drive to someone else or throwing it away.

What you will need to format the hard drive depends on a few things, such as whether it is your only hard drive and whether you have a spare PC or not.

You cannot, for example, format the hard drive on which Windows is running. In order to format the disk and reinstall Windows (or another operating system) you will need to boot your PC from a Windows installation disc, a USB flash drive or another bootable disc.

Formatting is the process of deleting all the data on the hard drive, but beware of 'Quick Format' which leaves all your data in place and makes the drive appear to be empty. A quick format is ok if you have a brand new hard drive, or you want to reinstall Windows, but not if you are disposing of the disk or giving it to someone else.

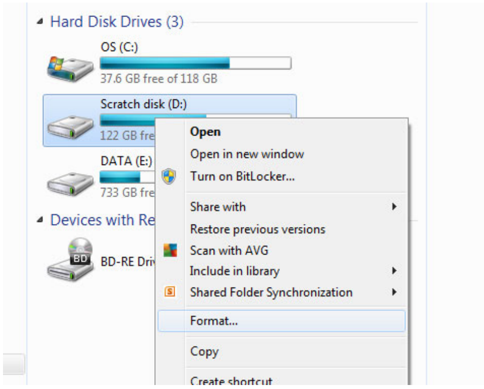
How to format a hard drive: partitions

It is important to understand about partitions before you start. A hard drive's storage can be divided up into smaller sections, called partitions. It is possible to format one partition while leaving the others untouched.

That is useful in certain situations, but if you want to format the entire hard drive and use the entire capacity in one block, you will also need to delete the partition information.

How to quick format a hard drive

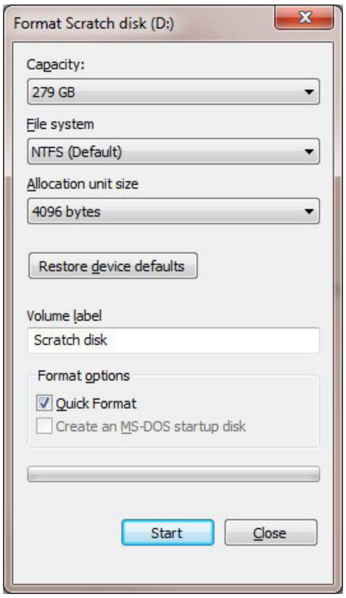
Windows Vista, 7 and 8 have a built-in **Disk Management** tool, but the fastest way to format a hard drive is to click the Start button, then Computer and right-click on the hard drive you want to wipe (you cannot format the drive on which Windows is installed for obvious reasons). Choose Format… from the menu and a new window will appear with a few formatting options.



Keyword

Disk Management is a system utility in Windows that enables you to perform advanced storage tasks.

By default Quick Format is checked, and you can choose the file system and allocation unit size as well as changing the volume label (the drive's name). Typically, you can leave all settings unchanged and click the Start button. In under a minute your hard drive will be formatted.

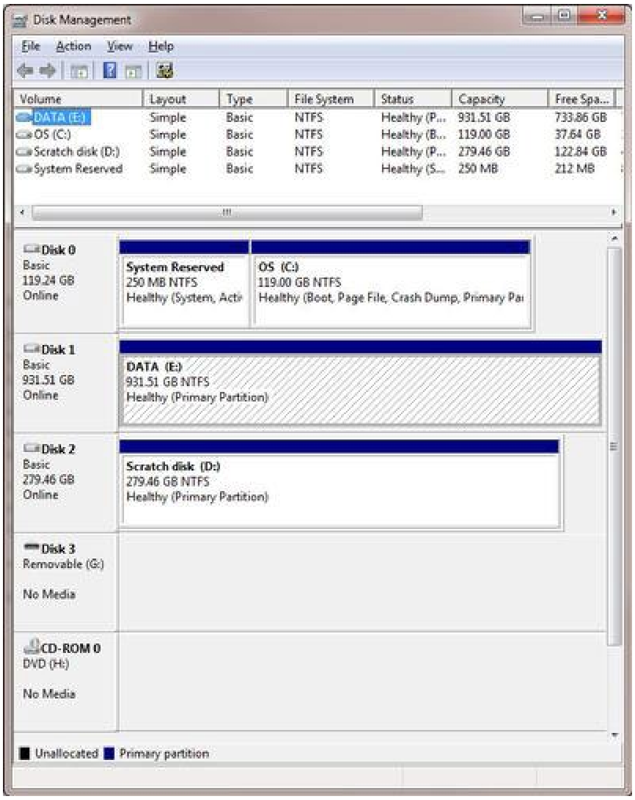


Using Windows' built-in Disk Management tool

Type diskmgmt.msc into the search box in Vista or Windows 7 and then click on only result that appears in the menu above, with the same name.

This is the easiest way to launch Disk Management, but you'll also find it in the Control Panel if you search for 'disk' or look under the Administrative tools section, where it is called 'Create and format hard disk partitions'.

Disk Management is not as powerful as a standalone partition management tool, but it is still useful.

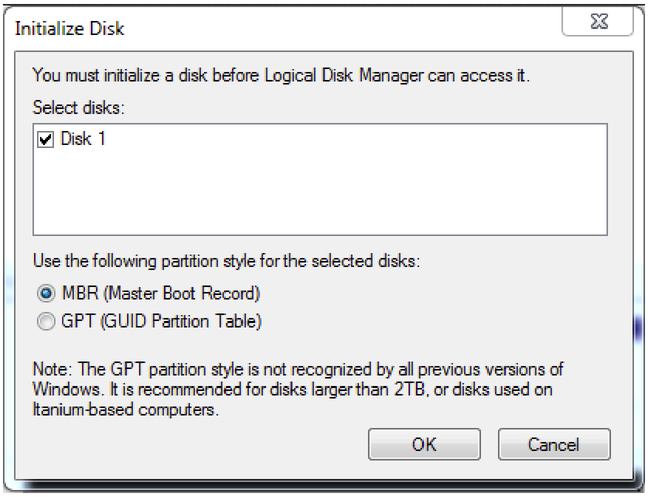


When you install a new (additional) hard drive in your PC, you might wonder why it does not appear in Windows Explorer. The reason is because it needs to be initialized and formatted - you can do this in Disk Management.

When the tool loads, it will analyses all computer's drives and will prompt you to initialize a new disk that it finds.

REMEMBER

A typical hard disk drive operates at a speed of 7,200 rpm (rotations per minute), so you will often see this number as part of the technical specifications of a computer. The spinning of the disk is also the source of the humming noise of a computer, although most modern hard disk drives are fairly quiet.



If your disk is larger than 2TB, you should opt for GPT (GUID Partition Table). This setting also lets you create more than four partitions.

If you do not see a prompt, look in the list of drives and you should see one that says 'Not Initialized'. Right-click on it and choose Initialize Disk.

Once that's done, right-click in the hatched Unallocated space and choose New Simple Volume…

Follow the instructions, choosing how big you want the partition to be (in MB - 1024MB = 1GB), and which drive letter you want (one will be chosen, but you can opt to change it if you wish).

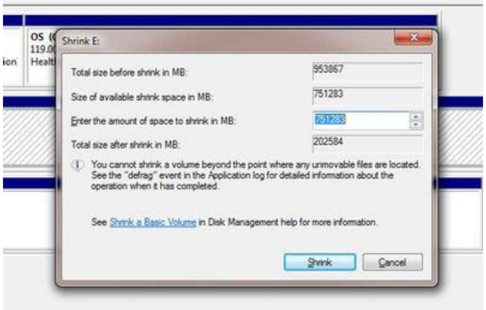
When you come to format the partition, our advice is the same as in the Quick Format section above.

If you select a size for the partition that's smaller than the total capacity of the drive, say 500B on a 1TB drive, you will end up with some unallocated space on the drive which you can format by repeating the process you have just completed.

Changing a Partition's Size

You can use Disk Management to expand or shrink a partition. Simply right-click on one and choose the appropriate option from the menu that appears. If shrinking, the partition will be checked to find out how much empty space it contains.

It is a little confusing as the numbers are displayed in MB rather than GB, but you can adjust the amount of space to shrink and the 'Total size after shrink' will be updated. You cannot shrink a partition beyond the point where files are located - you may be able to free up space by defragmenting the drive first.



4.4 BASIC TROUBLESHOOTING TECHNIQUES

Most people have at one time or another experienced a computer problem like the situations just described, and if you have not, chances are you will at some point. When a problem occurs, do not panic! Instead, work your way through some basic troubleshooting techniques to try and solve the problem.

4.4.1 General Guidelines

There are many devices, parts, cords, and connections on a computer, which means there are many possible problems that could arise. In addition, your computer uses a variety of software, which can also cause problems. However, no matter what the problem is, you can use the following tips to help you find a solution:

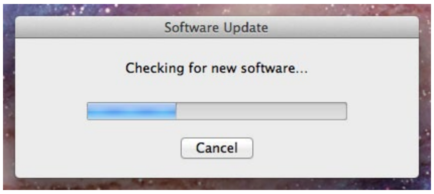
- ***Always check the cables***: Many computer problems are related to an issue with the cables and connections. The easiest first step you can take to troubleshoot most problems is to check all related cables and connections.
- ***Isolate the problem***: If possible, try to isolate the problem. For example, if you cannot get the cursor to move on the screen, try to determine if the issue is with the mouse. If you have an extra mouse, you can alternate devices to see if the one plugged in is the issue, or use the arrow keys on the keyboard to help determine if the mouse is the source of the problem. When trying to isolate the problem, only make one change at a time.
- ***Take notes about error messages***: If your computer gives you error messages, be sure to write down as much information as possible. If the basic troubleshooting steps do not work, you may need the information.
- ***Remember the steps you have taken, or write them down***: Once you start troubleshooting, you will want to remember what you have done so you do not repeat yourself. If you cannot remember it, write it down. If you end up asking people for help, it will be much easier if they know exactly which steps you have taken.

4.4.2 Simple Solutions to Common Problems

Most of the time, problems can be fixed by using simple troubleshooting techniques, like closing and reopening the program. it is important to try these simple solutions before resorting to more extreme measures. If the problem still is not fixed, you can try other troubleshooting techniques, like reinstalling the software.

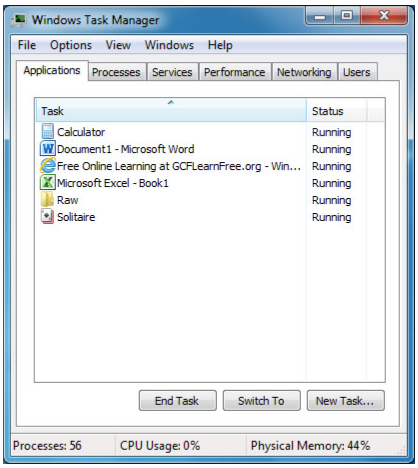
Program runs slowly or is not working properly

- If a program is running slowly or otherwise is not working right, the first thing you should try is closing the program and reopening it.
- You can also shut down your computer, wait a few seconds, and boot it up again. Some minor problems will work themselves out when you do this.
- Check with the company for any known problems or updates to the software.



Program is completely unresponsiv

If a program has become completely unresponsive, you can press (and hold) Control+Alt+Delete on your keyboard to open the Task Manager. You can then select the program that is not working and click End Task. If you are using a Mac, you can press Option+Command+Esc to open a similar dialog box.



4.4.3 Problems Starting or Shutting Down the Computer

Power button will not start computer

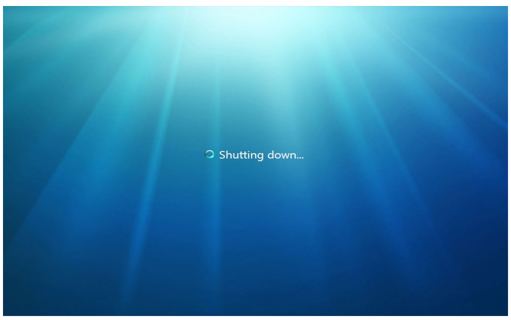
- If your computer does not start, begin by checking the power cord to confirm that it is plugged securely into the back of the computer case and the power outlet.
- If it is plugged into an outlet, make sure it is a working outlet. Often, this will require you to plug a lamp or other electrical device into the outlet to make sure it is receiving power.
- If the computer is plugged in to a surge protector, verify that it is turned on. You may have to reset the surge protector by turning it off and then back on. You can also plug a lamp or other device into the surge protector to verify that it is on.
- If you are using a laptop, the battery may not be charged. Plug the AC adapter into the wall, then try to turn on the laptop. If it still does not start up, you may need to wait a few minutes and try again.

"Non-system disk or disk error" Message

If you get this message when you boot up your computer, it usually means there is a CD, DVD, USB flash drive, or floppy disk in your computer, which is interfering with your computer's booting process. Remove the disk from the drive, and then restart the computer.

Windows shutting down message will not disappear

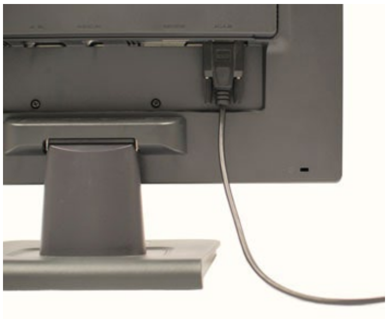
Sometimes Windows will freeze during the shutdown process. If this happens, the Windows is Shutting Down message screen will stay active on your screen. To finish shutting down the computer, press and hold the power button for about 10 seconds, or until the computer turns off.



4.4.4 Problems with the Monitor and Speakers

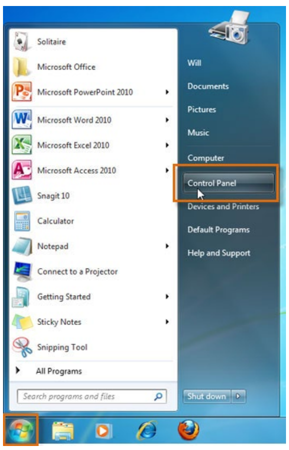
No picture on the monitor

- Confirm that the computer is turned on.
- Check the brightness control, located on your monitor or your keyboard, and make sure it is not set too low.
- Check the connections for the monitor and surge protector, and make sure the surge protector is turned on.



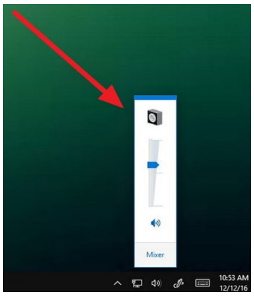
Monitor Goes Blank Periodically

You may have the screensaver enabled. If the screensaver is enabled, just move your mouse back and forth, and your original screen should appear. You can change the screensaver settings by going to your Control Panel (or your System Preferences if you're using a Mac).



No Sound

- Check the volume control on your computer. In Windows, the sound icon will usually be on the taskbar, and you can also access the sound options in the Control Panel. On Macs, the sound options are found at the top of the screen or in System Preferences.
- Most media programs (such as iTunes or Windows Media Player) have a volume control, which will need to be turned up.
- Make sure the speakers are turned on, if using external speakers.
- Make sure external speakers are connected to the correct audio port or a USB port. If your computer has color-coded ports, the audio output will usually be green.
- Connect headphones to the correct audio port, and determine if sound is audible from the headphones.



4.5 SCANDISK AND DEFRAG

Scandisk and Defrag are important utilities that come with Windows, to help you tune up your Windows file system and make sure it is running properly. Scandisk checks your drive to make sure there are not any problems with it, and Defrag (short for Disk Defragmenter) organizes your file system to help Windows read files faster.

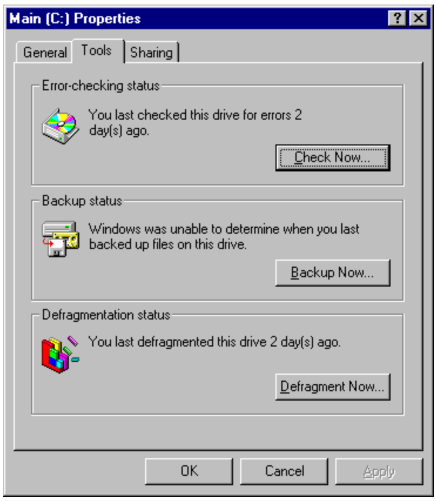
You can usually find Scandisk and Defrag on your Start menu under "Programs" then "Accessories" and "System Tools". Another easy way to access both programs is to open "My Computer", and right-click on the drive you want to tune up. On the context menu choose "Properties" and then select the "Tools" tab. If you use this second method to start Scandisk and Defrag, you should see a window like this:

As you can see, this window tells you how long it is been since you last ran Scandisk or Defrag on this drive. If you see a message like "Windows was unable to determine when you last checked this drive for errors", or "Windows was unable to determine when you last defragmented this drive", then you probably have not done it since Windows was installed.

Just like you periodically get your oil changed in your car, you should run Scandisk and Defrag now and then, to keep everything running smoothly. You should run Scandisk and Defrag at least once a month. Later versions of Windows (Windows 95B a/k/a OSR2 and later) will automatically run the DOS version of Scandisk before starting up, if the computer was not shut down properly before this boot. On these systems running Scandisk regularly is not as important, although there are some problems that the DOS version of Scandisk will not repair. It should be noted that running Scandisk and Defrag more than once a month is still helpful. Also, the more often you run Defrag, the less time it will take, because there is less work to do.

DID YOU KNOW ?

In Windows 95 onwards, ScanDisk also had a graphical user interface, although the text-based user interface continued to be available for use in single-tasking ("DOS") mode.



Keyword

ScanDisk: It is a DOS utility application used to check and correct errors on hard and floppy disks. It was first shipped in DOS 6.2 and was included with Windows 95, 98 and ME.

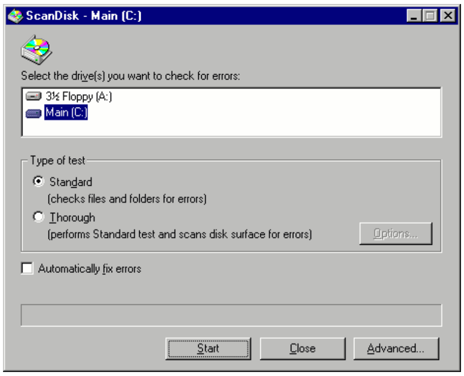
4.5.1 Running Scandisk

When you first start **Scandisk**, you should be greeted by a window similar to this:

At the top you will find a box that lets you select which drives you would like to check for errors. If you want to have Scandisk check multiple drives, you can hold down the Ctrl key while selecting them. Usually you will just select the one drive you are interested in.

Moving downwards, there are two radio buttons, called Standard and Thorough. A standard test completes fairly quickly, but only checks the FAT tables and directory entries.

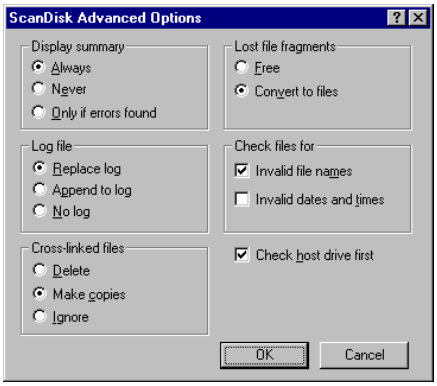
The Thorough test can take a long time, but performs a test on each sector of a drive. This test is similar to the one performed when formatting the drive.



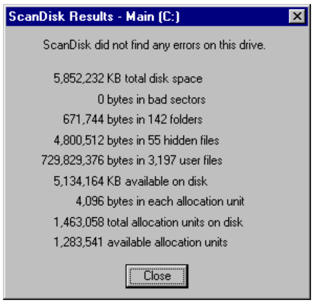
Almost all of the time, you would recommend using the Standard option. Any errors that are not due to a failure of the hardware can be detected with a Standard scandisk. On the other hand, if you suspect the hardware is having problems, or sectors on the drive are going bad, choose the thorough option.

The checkbox near the bottom named "Automatically fix errors" is controls the behavior of Scandisk when a problem is found. If you leave this box unchecked, Scandisk will stop and ask you what course of action to take, for each error it finds. Scandisk's default actions are pretty safe, so it is okay to leave this checked.

The image to the left shows the dialogue box presented after clicking the advanced button. The default settings are shown here, and there is little reason to change them.



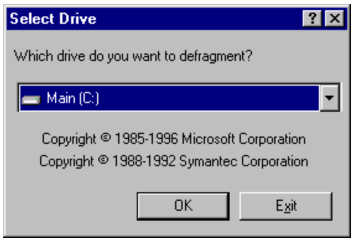
Most of the settings are self-explanatory. "Check host drive first" applies only to compressed drives. A compressed drive must be contained within an uncompressed drive, and checking this option tells Scandisk the uncompressed drive first.



The image to the right shows the Scandisk results window. "KB total disk space" is the usable size of your disk, left over after the FAT file system overhead. "KB available on disk" is the total free space left. "Bytes in each allocation unit" is the cluster size of this file system. "Allocation units on disk" and "available allocation units" are the same as "KB total disk space" and "KB available on disk", respectively, except expressed in units of clusters instead of kilobytes. To convert from clusters to kilobytes, you can multiply by the "bytes in each allocation unit" field, then divide by 1024.

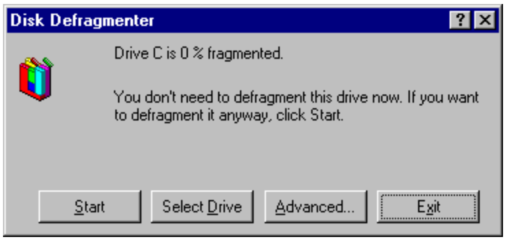
4.5.2 Running Defrag

After starting Defrag, you will see a window similar to this, asking which drive you would like to defragment. Unlike Scandisk, there is no way to select multiple drives simultaneously. In Windows 98, the defragmentation process will start as soon as you hit the `OK' button, so the `Settings' button is also on this window.

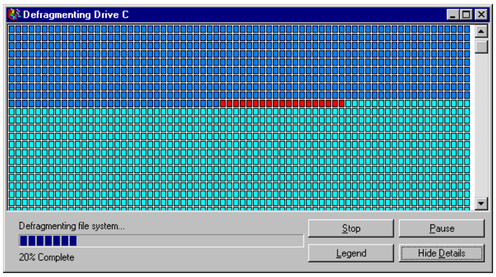


To the right is the main Defrag window. Under Windows 95, you will usually just click the `Start' button. Under Windows 98, Defrag will automatically start working, so there is no need. The `Advanced' button here takes you to Defrag's settings.

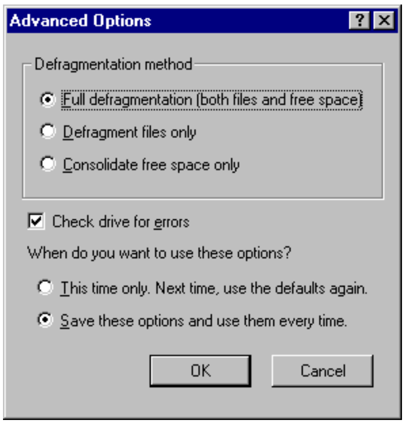
After Defrag has started working, it will display a percentage bar showing how much of the drive has been defragmented already. At this time you can click the `Show Details' button if you wish to watch Defrag moving the blocks of data around your drive. It is not a very useful option, but it can be fun to watch, especially if you're bored waiting for your Defrag to finish. If you have a slower computer, using this option may slow Defrag down noticably, but anything faster than a Pentium 166 with a decent video card would not experience a significant slowdown.



On the left you can see a screenshot of Defrag in action, when Show Details mode is on. Hitting the Legend button will detailing what the different coloured blocks mean? The Pause button will halt Defrag temporarily, and Stop will cancel your defragmentation.



Here is a screenshot of the Defrag settings under Windows 95. The default options are shown here. There are 3 choices for the Defragmentation Method. The first is `Full', which is the best choice. It moves files so that they occupy continuous ranges of clusters, and Windows can read them faster. It also tries to make the space not used up by files into one large block. The second choice is `Files only'. With this option you will get the benefits of defragmenting the file system, but since the free space may still be scattered around the disk, new information written to the disk will more easily become fragmented again. The third option, `Free space only', does not optimize any of your current files, but will help make sure new ones do not fragment.



You should leave the "Check drive for errors" option checked. It does not take much time to do a quick check of your drive before the Defrag, and you risk losing data if you try to defragment a corrupted file system.

The Windows 98 Defrag has fewer settings. Again there is an option to check the drive for errors, and one to tell Windows to rearrange your files so that they load quicker. I do not know of any downside to that option, and it does improve performance, so leave it checked.

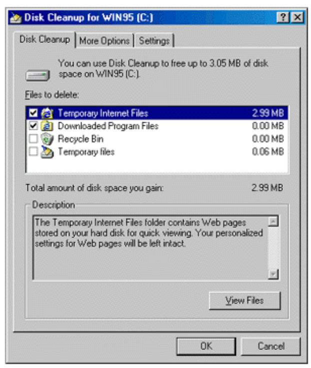
When Defrag is done, it will present you with this window. Just hit `Yes' unless you want to defragment another drive.

Keyword

Disk Cleanup: It is a computer maintenance utility included in Microsoft Windows designed to free up disk space on a computer's hard drive. The utility first searches and analyzes the hard drive for files that are no longer of any use, and then removes the unnecessary files.

4.5.3 Disk Cleanup Utility

To keep a PC running smoothly, regular maintenance is critical. Many users shy away from maintenance tasks, thinking it is a long, drawn out manual affair, but the **Disk Cleanup** Utility can easily determine which files on a hard drive may no longer be needed and delete those files. In addition to freeing up potentially significant amounts of hard drive space, using Disk Cleanup on a regular basis can significantly improve system performance.



Starting Disk Cleanup

Disk Cleanup is available on both Home and Professional versions of XP. The utility can be accessed using the methods listed.

- Click Start | Programs | Accessories | System Tools | Disk Cleanup
- Click Start | Run and in the Open box type cleanmgr and click OK
- In Windows Explorer or My Computer, right-click the disk in which you want to free up space, click Properties, click the General tab, and then click Disk Cleanup.

ROLE MODEL

ALAN F. SHUGART WAS FOUNDER OF COMPUTER DISK DRIVE

Alan F. Shugart, an engineer and entrepreneur whose career defined the modern computer disk drive industry, died Tuesday in Monterey, Calif. He was 76.

The cause was complications after a recent heart operation, said his son-in-law Mark Peterson.

Beginning his career as an I.B.M. field service engineer repairing punch card accounting machines in 1951, Mr. Shugart was intimately involved in every important juncture of the computer storage industry for more than four decades. Over that time computer storage systems shrank from monsters the size of large washing machines to compact boxes that fit in the palm of the hand. At the same time, digital storage capacities soared from the equivalent of several books to whole libraries. After transferring to an I.B.M. research laboratory in San Jose, Calif., in 1955, Mr. Shugart helped develop the first disk drive, named the Ramac, for random access method of accounting and control, which was able to store five million characters of data. I.B.M. introduced the Ramac commercially in 1959 and initially rented the system for $750 a month. The drives required an air compressor, which rented for an additional $150 a month, Mr. Shugart recalled in a lecture given several years ago.

During his 18 years at I.B.M. he managed the development of a number of products, including the I.B.M. 1301, a 50-megabyte disk system that was the basis for Sabre, the nation's first online reservation system, which I.B.M. created for American Airlines, said Jack Harker, a longtime I.B.M. engineer who worked with Mr. Shugart.

At I.B.M., Mr. Shugart rose to become director of engineering for the systems development division, but left to join Memorex in 1969, eventually taking several hundred I.B.M. engineers with him.

In 1972 he left Memorex to found Shugart Associates, which introduced a lower-cost 8-inch form-factor floppy disk drive.

The technology was intended for a new class of smaller computers that were moving outside of the corporate data center, according to Finis Conner, a longtime business partner and sometime competitor of Mr. Shugart.

At an early planning meeting, Mr. Conner recalled, the two men sketched out a simple graph on a napkin showing how cost would fall as volume increased.

''It was a march to mobility, taking the computing power out of the computing room and putting it into the desktop,'' said Mr. Conner, who first worked for Mr. Shugart at Memorex in the 1970s.

Before starting Seagate, Mr. Shugart took a five-year hiatus from the computer industry, having been forced out at Shugart Associates in 1974 after a disagreement with the board. During the break, he moved to Santa Cruz, Calif., where he helped open a bar with friends and bought a fishing boat.

In 1979, with Mr. Conner, he returned to the computer storage industry. The two founded Seagate Technology, the first maker of 5.25-inch hard disks, in 1979. At that time storage for personal computers was based on 5.25-inch floppy disks, and the two realized that a hard disk system of the same size but with a higher capacity would find a ready market.

The company's first product stored five megabytes and sold for $1,500. It became an instant best seller, driven by the exploding growth of companies like Apple Computer, its first customer, and others.

Born in Chino, Calif., in 1930, Alan Field Shugart studied engineering physics at Redlands University and started work at I.B.M. the day after he graduated. After leaving Seagate, he founded Al Shugart International, a venture capital company.

He is survived by his wife, Rita, of Pebble Beach, Calif.; a sister, Margaret Kraght, of Glendora, Calif.; a son, Chris, of Monterey, Calif.; his daughters, Teri, of San Carlos, Calif.; Jill Bambace, of Aromas, Calif.; Mia Peterson of Carmel, Calif.; and Dana Bambace, of Carmel, Calif.; and seven grandchildren.

Although Mr. Shugart was a leading figure in an industry characterized by constant technical innovation, he was financially conservative and took pride both in an informal business style and in focusing on business basics. He was also typical of a plain-spoken generation of Silicon Valley engineers who had little tolerance for bureaucracy or perceived phoniness. In 1996, he tried to run his Bernese mountain dog Ernest for Congress in a protest against the direction of both the country's major political parties.

SUMMARY

- A hard drive is a piece of hardware used to store digital content and data on computers. Every computer has an internal hard drive, but you can also get external hard drives that can be used to expand the storage of a computer.
- All digital data comes in the form of binary code—a series of ones and zeros that can represent any piece of information. The read/write heads of a hard drive are used to input these ones and zeros by magnetizing portions of the platter.
- A computer requires an operating system to allow users to interact with and use it. The operating system interprets keyboard and mouse movements and allows for the use of software, like an Internet browser, word processor, and video games.
- A hard drive is also required for the installation of any programs or other files you want to keep on your computer. When downloading files to your computer, they are permanently stored on your hard drive or another storage medium until they are moved or uninstalled.
- FAT file systems are characterized by the use of a file allocation table and clusters (or blocks). Clusters are the smallest unit of storage in a FAT file system. A cluster actually represents a fixed number of disk sectors.
- Extended partitions were developed to overcome the limit of four primary partitions, as you can create as many logical drives as you want in them.
- Installing an internal hard drive is one of the more straightforward upgrades out there and is often a better option than using external drives that are slower and may be dropped or misplaced.

KNOWLEDGE CHECK

1. **Winchester drive is also called:**
   a. Hard Disk Drive
   b. Floppy Disk Drive
2. **Which is the best hard disk seek time?**
   a. 3ms
   b. 5ms
3. **When auto detecting an IDE hard drive, which of the following options you can choose for setting up the drive?**
   a. ECHS (enhanced, cylinders, heads, sectors)
   b. EBA (enhanced block addressing
   c. LBA (logical block addressing)
   d. All of the above
4. **Which tool in Window Me enables you to check your hard drive for errors?**
   a. Disk Defragmenter
   b. Scandisk
   c. Check Disk
   d. Disk Manger
5. **How many partitions can you create on a single hard drive using FDISK?**
   a. One
   b. Two
   c. Three
   d. Four
6. **After doing a low-level format, what would be the next step in configuring the hard drive in a system?**
   a. Format DOS partition
   b. Install operating system
   c. Configure DMA channel and back-up interrupt
   d. Partition had disk
7. **What's the best way to protect your hard drive data?**
   a. regular backups
   b. periodically defrag it
   c. run chkdsk at least once a week
   d. run scandisk at least once a week

8. A parity error usually indicates a problem with:

a. memory

b. hard drive

c. hard drive controller

d. I/O controller

REVIEW QUESTIONS

1. What do you mean by the hard drive?
2. How is data read and stored on a hard drive?
3. How can be Using Multiple Partitions? Explain
4. What do you mean by basic troubleshooting techniques?
5. Discuss the scandisk and defrag.

Check Your Result

1. (a)	2. (b)	3. (d)	4. (b)	5. (b)
6. (a)	7. (a)	8. (a)		

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CHAPTER 5

SOUND AND VIDEO

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Discuss about the sound
2. Describe the term video
3. Define CRTs
4. Explain the term LCDs
5. Understand by video RAM
6. Explain the troubleshoot monitor and video card problems

"We designed a number of features from the ground up, like custom display and optics technology with very high refresh rates and pixel density. We added integrated 3-D audio, a built-in microphone so you can speak to friends inside virtual worlds, and precise mechanical adjustment systems."

—Brendan Iribe

INTRODUCTION

Sound, any disturbance that travels through an elastic medium such as air, ground, or water to be heard by the human ear. When a body vibrates, or moves back and forth, the oscillation causes a periodic disturbance of the surrounding air or other medium that radiates outward in straight lines in the form of a pressure wave. The effect these waves produce upon the ear is perceived as sound.

The terms audio and video commonly refers to the time-based media storage format for sound/music and moving pictures information. Audio and video digital recording, also referred as audio and video codecs, can be uncompressed, lossless compressed, or lossy compressed depending on the desired quality and use cases.

Audio codecs can usually contain one audio channel (mono), two audio channels (stereo), or more channels (e.g. “5.1” surround). For example, human voice is recorded using one channel while music uses in general two or more channels. The quality will vary depending on the bitrate, ie the number of bits used per unit of playback time.

Video codecs will contain a sequence of frames, i.e. still pictures and, for compressed formats, movements between those pictures. Quality will vary depending on the number of frames per second, color space, resolution, etc.

Media storage formats will contain audio codec streams, video codec streams, captions, and meta information. It combine them to provide the audio or the video, with alternative or enhanced materials. In general a video will have one video codec stream, one or more alternative audio codec streams, and may have captions and Meta information.

Audio and video are used for enhancing the experience with Web pages (e.g. audio background) to serving music, family videos, presentations, etc. The Web content accessibility guidelines recommend to always provide alternatives for time-based media, such as captions, descriptions, or sign language.

5.1 SOUND

Sound is a mechanical disturbance from a state of equilibrium that propagates through an elastic material medium. A purely subjective definition of sound is also possible, as that which is perceived by the ear, but such a definition is not particularly illuminating and is unduly restrictive, for it is useful to speak of sounds that cannot be heard by the human ear, such as those that are produced by dog whistles or by sonar equipment.

Sound should begin with the properties of sound waves. There are two basic types of wave, transverse and longitudinal, differentiated by the way in which the wave is propagated. In a transverse wave, such as the wave generated in a stretched rope when one end is wiggled back and forth, the motion that constitutes the wave is perpendicular, or transverse, to the direction (along the rope) in which the wave is moving. An important family of transverse waves is generated by electromagnetic sources such as light or radio, in which the electric and magnetic fields constituting the wave oscillate perpendicular to the direction of propagation.

Sound propagates through air or other mediums as a longitudinal wave, in which the mechanical vibration constituting the wave occurs along the direction of propagation of the wave. A **longitudinal wave** can be created in a coiled spring by squeezing several of the turns together to form a compression and then releasing them, allowing the compression to travel the length of the spring. Air can be viewed as being composed of layers analogous to such coils, with a sound wave propagating as layers of air "push" and "pull" at one another much like the compression moving down the spring.

A sound wave thus consists of alternating compressions and rarefactions, or regions of high pressure and low pressure, moving at a certain speed. Put another way, it consists of a periodic (that is, oscillating or vibrating) variation of pressure occurring around the equilibrium pressure prevailing at a particular time and place. Equilibrium pressure and the sinusoidal variations caused by passage of a pure sound wave.

A sound wave is a type of pressure wave caused by the vibration of an object in a conductive medium such as air. When the object vibrates, it sends out a series of waves which can be interpreted as sound. *For example,* when someone hits a drum, it causes the membrane of the drum to vibrate, and the vibration is transmitted through the air, where it can reach the ear of a listener. Vibrations travel at different speeds through different media, but cannot travel through a vacuum. Aside from being used for communication, sound waves are employed to provide images of inaccessible objects and structures, in oceanic surveys, and in geology and seismology.

Keyword

Longitudinal waves are waves in which the vibration of the medium is parallel to the direction the wave travels and displacement of the medium is in the same (or opposite) direction of the wave propagation.

REMEMBER

As Apple has demonstrated with iTunes, getting started with computer audio is and should be fast and simple regardless of whether you're using a Mac or a Windows-based PC.

The Speed of Sound

The speed at which sound travels depends on the density of the medium through which it is traveling. It travels more quickly through denser media, and is therefore faster in solids than in liquids, and faster in liquids than in gasses. In familiar, earthly, conditions, the speed of sound is always enormously less than that of light, but in the super-dense material of a neutron star, it may come quite close to light speed. The difference in speeds through air is demonstrated by the delay between a flash of lightning and the sound of thunder for a distant observer: the light arrives almost instantaneously, but the sound takes a noticeable amount of time.

The speed of sound in air varies with pressure and temperature, with higher pressures and temperatures giving higher speeds. As an example, at 68°F (20°C), and standard sea-level pressure, it is 1,126 feet per second (343.3 meters per second). In water, the speed is again temperature dependent; at 68°F (20°C) it is 4,859 ft/sec (1,481 m/s). The speed in solids is very variable, but some typical values are 13,700 ft/sec (4,176 m/s) in brick, 20,000 ft/sec (6,100 m/s) in steel, and 39,400 ft/sec (12,000 m/s) in diamond.

Wavelength, Frequency, and Amplitude

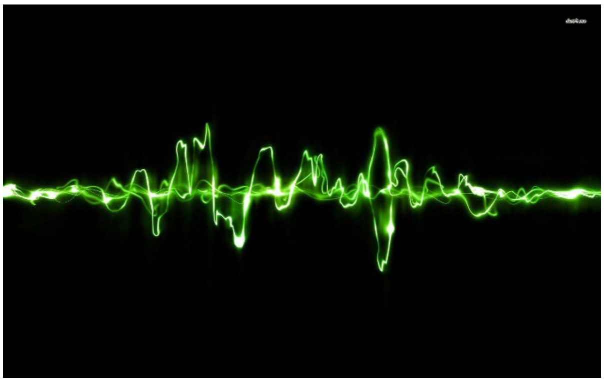
Sound can be described in terms of wavelength, frequency and amplitude. The wavelength is defined as the distance it takes for a complete cycle to be completed. A complete cycle moves from peak to peak or trough to trough.

Frequency is a term used to describe the number of complete cycles within a set period of time, so shorter wavelengths have higher frequencies. It is measured in hertz (Hz), with one hertz being one cycle per second, and kilohertz (kHz), with one kHz being 1,000 Hz. Humans can hear sounds ranging from 20 Hz to about 20 kHz, but vibrations can have much lower, or higher, frequencies. The hearing of many animals extends beyond the human range. Vibrations that are below the range of human hearing are called infrasound, while those above that range are known as ultrasound.

The pitch of a sound depends on the frequency, with higher pitches having higher frequencies. The amplitude is the height of the waves and describes the amount of energy carried. High amplitudes have higher volumes.

Wave Phenomena

Sound waves are subject to many of the phenomena associated with light waves. *For example,* they can be reflected from surfaces, they can undergo diffraction around obstacles, and they can experience refraction when passing between two different media, such as air and water, all in a similar manner to light. Another shared phenomenon is interference. When sound waves from two different sources meet, they can reinforce one another where the peaks and troughs coincide, and cancel one another out where peak meets trough, creating an interference pattern, with loud and quiet areas. If the vibrations have different frequencies, this can create a pulsed effect or a "beat" in the combined sound.



Applications

Sound waves have many applications in science and medicine. Ultrasound imaging can be used to investigate medical problems and carry out important checks. One well-known application is an ultrasound scan, used to produce an image of an unborn child, in order to check on its health where an X-ray would not be safe. Sound pulses, known as sonar, can be used to map the ocean floor by precisely measuring the time taken for an echo to be received.

In seismology, the inner structure of the Earth can be investigated by observing the propagation of sound waves. Since transverse waves cannot travel through liquids, this technique can be used to map out areas of molten rock under the surface. Typically, sound is generated by an explosion, and the vibrations are picked up at various distant points, having traveled through the Earth. By examining the pattern of transverse waves known as "s-waves" in this context and longitudinal waves known as "p-waves" an accurate three-dimensional map can be built up, showing the distribution of solid and molten rock.

5.1.1 How Sound Works in a PC

Like the ripples that roll across a pond when you drop a rock in the center, sound flows from a source in invisible but measurable waves that cause the membranes in ears to vibrate and create sound.

The sophistication of the human ear enables most people to differentiate the melodious from the raucous, the loud from the soft. Computers are not nearly as sophisticated as the human ear and brain, so clear standards are a must for converting music into a format that a PC can use to record and play sound. Computer folks use the terms capture and output instead of record and play.

Before the invention of the sound card, a PC could make one sound a beep. Although the computer could change the beep's frequency and duration, it could not change the volume or create other sounds.

Sound-Capture Basics

Virtually every PC today comes with four critical components for capturing and outputting sound: a sound card, speakers, microphone, and recording/playback software. Computers capture (record) sound waves in electronic format through a process called sampling. In its simplest sense, sampling means capturing the state or quality of a particular sound wave a set number of times each second. The sampling rate is measured in units of thousands of cycles per second, or kilohertz (KHz). The more often a sound is sampled, the better the reproduction of that sound. Most sounds in the PC world are recorded with a sampling rate of from 11 KHz (very low quality; like a telephone) to 192 KHz (ultra-high quality; better than the human ear). Sounds vary according to their loudness (amplitude), how high or low their tone (frequency) and the qualities that differentiate the same note played on different instrument (timbre). All the characteristics of particular sound wave amplitude, frequency, timbre need to be recorded and translated into ones and zeroes to reproduce that sound accurately within the computer and out to the speakers.

The number of characteristics of a particular sound captured during sampling is measured by the bit depth of the sample, the number of bits used to describe the characteristics of a sound. The greater the bit depth used to capture a sample, the more characteristics of that sound can be stored and thus re-created. An 8-bit sample of a limit Hendrix guitar solo, *for example,* captures 26 (256) characteristics of that sound per sample. It would sound like a cheap recording of a recording, perhaps a little flat and thin. A 16-bit sample, in contrast, captures 2” (65,536) different characteristic of his solo and reproduces all the fuzzy overtones and feedback that gave Hendrix his unique sound. The last aspect of sound capture is the number of different tracks of sound you capture. Most commonly, you can capture either a single track (monaural) or two tracks (stereo). More advanced captures record many more sound tracks, but that is a topic for a more advanced sound capture discussion. The combination of sampling frequency and bit depth determines how faithfully a digital version of a sound captures what ear would hear. A sound capture is considered CD quality when recorded at 44.1 KHz, with 16-bit depth, and in stereo. Most recording programs let you set these values before you begin recording.

If you want to play a 96kHz song the Audio MIDI Setup output must also be set to 96khz. If the Audio MIDI Setup is set to 44.1kHz and you select a 96kHz song it will still play, it just won't play at the native rate of the file.

5.1.2 Musical Instrument Digital Interface (MIDI)

MIDI is a communications protocol that allows digital instruments to interact with each other and with computers. MIDI has become the primary digital production tool for musicians since its invention in 1983. A MIDI file contains no sounds, just instructions describing the notes played in a performance and related information.

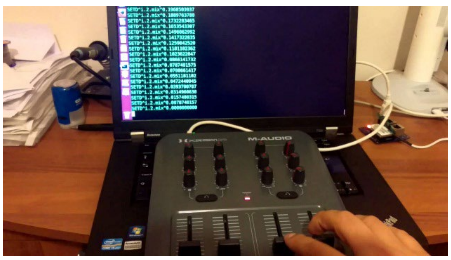
The MIDI protocol was initially designed to control digital keyboards, but as soon as computers entered the studio, they were connected to the MIDI chain. Then software became available for recording, printing, and editing musical symbols, just as word processors and graphic design programs proliferated for working with other media types. Keyboard synthesizer technology made major advances and became very popular in the 1980s. New methods of generating sounds were the focus of considerable research and development. The synthesizer joined the world of widely used musical instruments. One desirable method of creating sounds with synthesizers was to "layer," or combines the timbres of more than one instrument. A small group of synthesizer design technicians from different manufacturers met in 1983 to discuss a communications protocol to control a number of synthesizers from one key-board. They developed a method of connecting two synthesizers from competing manufacturers with cables that allowed either instrument to control the other. They called it the Musical Instrument Digital Interface, or MIDI.

Keyword

MIDI (Musical Instrument Digital Interface): It is a technical standard that describes a protocol, digital interface and connectors and allows a wide variety of electronic musical instruments, computers and other related devices to connect and communicate with one another.

The MIDI Protocol

Two synthesizers can communicate using MIDI in the same way that two computers can communicate over modems. The data exchanged between MIDI devices describes the performance of musical notes. MIDI information contains commands that instruct an instrument when to start and stop playing a specific note. Additional information translates the velocity of a keystroke into the volume of a note. MIDI information can be hardware-specific. It can tell a synthesizer to change sounds, which are referred to as instruments, programs, patches, voices, or timbres. Master volume, modulation of tones, and other types of data can be transmitted. MIDI information can start and stop a song, or sequence of events, and identify a location within a song. Computers can edit and store information that defines the sounds that reside in a synthesizer. A distinction may be made between a synthesizer that uses oscillators to electronically create a sound and a sampler that plays back a looped recording of a sound wave. Memory in samplers and sound cards holds a “wave table” of samples, containing short recordings of live instrument sounds. The basic unit of communication used in MIDI is the byte. Each MIDI command has its own particular byte sequence. The first byte is the status byte, which tells the MIDI device what function to perform. The status byte contains the MIDI channel that is being addressed. MIDI data can flow on 16 different channels simultaneously. Depending on the mode of reception and the channel to which a MIDI unit is set to receive, it will accept or ignore a status byte. The bytes that follow the status byte address the particular channel indicated by the status byte until another status byte is received. The status byte sends commands such as Note On, Note Off, and Patch Change. Depending on the status byte, a number of different byte patterns will follow. The Note On status byte tells the MIDI device to play a note. This status byte requires a note-number byte to identify the note and a velocity byte to define the volume. These bytes are required to complete the Note On transmission. A separate Note Off command is sent to stop the note, which is not part of the Note On command. This command also requires the same two additional bytes as the Note On byte. Another example of a status byte is the Patch Change byte. The additional byte required by this command is the number of the new patch or voice on the synthesizer. It is important to select the desired channel when sending a Patch Change command. Patch Change data is different on every synthesizer. The International MIDI Association (IMA) has set standards, and each manufacturer has an ID number. The SysEx status byte, which requires at least three additional bytes, can perform a variety of functions. The first additional byte is the manufacturer’s ID number, the second is a data format byte, and the third is an end of transmission (EOX) byte.



5.1.3 Purchasing the Right Sound Card for PC

Sound cards come with many built-in features, including two separate sound processors (one for all of the recorded formats such as WAV and another for MIDI), support chips for joysticks and other pointing devices that plug into the game port, recording capabilities, support for MIDI instruments, and more. All sound cards, from the cheapest to the most expensive, can play music and drive a pair of speakers, so techs need to delve a little deeper to understand the crucial differences among low-, mid-, and high-end sound cards. Sound cards differ in five basic areas: processor capabilities, speaker support, recording quality, jacks, and extra features. But the sound card itself is only one part of the equation. You also need good-quality speakers if you have any intention of listening to music or enjoying some of the more advanced features such as surround sound. If you want to add a sound card to the computer, or upgrade the sound card that it already has, you have several options. A number of specialized PC sound cards are available for the discriminating audio connoisseur:

An MP3 Card

If you are an MP3 wizard with a hard drive's worth of MP3 digital audio files, you shall appreciate one of these specialized audio cards. An MP3 card contains a hardware encoder/decoder, which speeds up the PC's ripping (the process of creating MP3 digital audio files from existing audio CDs) and MP3-playing performance.

A 24-bit card

For the absolute best in audio reproduction, go for 24-bit audio (that is 192 KHz, for you audio heads), which is far superior to the sound produced by virtually all audio CD players. These cards can also support DVD audio, feature front-panel controls that fit in an open drive bay, and carry a built-in FireWire port which is just the whipped cream and cherry on the sundae.

A Surround Sound Card

These cards are specifically designed for 3D environmental audio within games and for full Dolby surround sound support when you watch DVD movies on the PC. Naturally, you need more than two mundane speakers from a discount store to enjoy the full effect which is why a premium set of speakers is usually included with these cards.

5.1.4 Processor Capabilities

Sound processor capabilities differ dramatically from the low end to the high end, even though the prices do not reflect the great divide. The sound processor handles the communication among the application, **operating system,** and CPU and translates commands into sounds coming out of the speakers. Low-end sound processors do little more than translate, which means that the CPU has to do the heavy lifting on the processing front. Better sound processors, in contrast, shoulder much of the processing burden and bring a series of extra features to the table. By handling a lot of the processing on board, these better sound processors free up the CPU for other duties and, in effect and in name, accelerate the sound process. These decent sound processors also provide excellent sound reproduction, so the MP3s sound as awesome on the PC as they do on the stereo. Most mid-range and all high-end sound processors offer support for various surround sound standards, enabling equally equipped games and other applications to provide positional audio effects and detailed sound modeling features that make PC gaming take on a whole new dimension.

Keyword

Operating system is system software that manages computer hardware, software resources, and provides common services for computer programs.

5.1.5 Speaker Support

Every **sound card** supports two speakers or a pair of headphones, but many better sound cards support five or more speakers in discrete channels. These multiple speakers provide surround sound popular not only for games but also for those who enjoy playing DVDs on their PCs.

Another popular speaker addition is a subwoofer. Subwoofers provide the amazing low-frequency sounds that give all of the sounds, from the surround sound of a game to the music of a simple stereo MP3 file, an extra dimension. Almost all modem sound cards support both surround sound and a subwoofer and advertise this with a nomenclature such as Dolby Digital, DTS, or 5.1. The 5 denotes the number of speakers: two in front, two in back, and one in the center. The .1 denotes the subwoofer.

Speaker Features Speakers also come with a few other features that you should consider when choosing a set for yourself or the clients. Speakers offer a variety of power sources, controls accessibility, and headphone jacks.

Keyword

Sound Card: It is an internal computer expansion card that facilitates economical input and output of audio signals to and from a computer under control of computer programs.

Controls

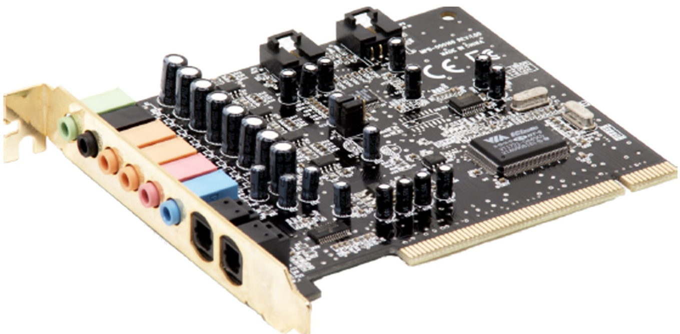
All speakers have volume controls as well as an on/off switch. Get a sys-tem that provides easy access to those controls by placing them on an easy to reach speaker or on a special control box.

Headphone Jack

The problem with headphones is that you need to plug them into the back of the sound card and then tell windows to output to them from the Sound applet on the control panel. Save yourself a lot of hassle and get a speaker system that has a handy microphone jack on one of the speakers or on a control box.

5.1.6 Installing a Sound Card in a Windows System

You have got two choices for sound hardware on today's PCs: onboard sound built into the motherboard or a separate sound card. The installation process for a sound card is basically the same as the process for any other card. You snap the card into a slot, plug some speakers into the card, load a driver and for the most part, you are done. With onboard sound, you need to make sure the sound is enabled in the CMOS and then load the driver. As with most of the devices discussed in this book, sound card installation consists of three major parts: physical installation, device driver installation, and configuration.



Physical Installation

Physical installation is easy. Onboard sound is already physically installed and most sound cards are run of the mill PC1 cards. The real trick to physical installation is deciding where to plug in the speakers, microphone, and so on. The surround sound devices so common today feature a variety of jacks, so you will probably want to refer to the sound card documentation for details, but here are a few guidelines:

- The typical stereo or 2.1 speaker system will use only a single jack. Look for the jack labeled Speaker or Speaker 1.
- Surround speakers either use a single digital (S/PDIF) connection, which runs from the sound card to the subwoofer or they need three separate cables: one for the front two speakers that runs to the Speaker 1 connector, one for the back two speakers that runs to the Speaker 2 connector, and a third cable for the center channel and subwoofer that runs to the digital/audio out or Speaker 3 connector.

Here is a quick look at sound card installation. As with any PCI card, you shall need a Phillips-head screwdriver to install a sound card, as well as the electrostatic discharge (FSD) prevention equipment. Of course, you shall also need the sound card itself, a set of speakers, an audio cable, and a microphone if you want to be able to record sounds.

- Shut down the computer, unplug it, and open the case.
- Find an open PCI slot and snap in the sound card. Remember to handle the card with tender loving care especially if you are installing an expensive, high-end card! Make sure that the card is securely seated, and secure it to the chassis with a hex screw.
- Now connect the CD audio cable to the back of the optical drive and plug the other end into the CD audio port on the sound card. Be sure to use the correct connector many sound cards have multiple audio connectors.

After the sound card and driver are installed, make a quick trip to the Device Man-ager to ensure that the driver was installed correctly, and you are two-thirds of the way there Installing the driver is never the last step for a sound card. The final step is to configure the sound card using configuration programs and test it using an application. Most sound cards come with both special configuration programs and a few sound applications on the same CD-ROM that supplies the drivers.

Installing Sound Programs

You have already seen that you need a program to play sounds on the PC: Windows Media Player, Win amp, or something similar. But two other classes of sound programs also reside on the computer: programs for the configuration of the sound card and special applications that may or may not come with the sound card.

Configuration Applications

Every Windows computer comes with at least one important sound configuration pro-gram built right into the operating system: the Control Panel applet called Sounds and Audio Devices in Windows XP or Sounds and Multimedia in Windows 2000.

Whatever the name, this applet (or applets) performs the same job: it provides a location for per-forming most or all the configuration you need for the sound card. The Sounds and Audio Devices applet in Windows XP, for example; the Sounds and Multi-media applet in Windows 2000 works roughly the same, although it may have one control or another in a different place. The Sounds and Audio Devices applet has five tabs: Volume, Sounds, Audio, Voice, and Hardware. This Volume tab is the most stimulating. This tab adjusts the volume for the speakers, and it allows you to set up the type of speaker.

5.1.7 Troubleshooting Sound

The problems you shall run into with sound seem to fall into one of two camps: those that are embarrassingly simple to repair and those that defy any possible logic and are seemingly impossible to fut. The sound problems are categorized into three groups' hardware, configuration, and application problems.

Hardware Problems

Hardware problems are by far the most common sound problems, especially if the sound card has worked for some amount of time already. Properly installed and configured sound cards almost never suddenly stop making sounds.

Volume

The absolute first item to check when a sound dies is the volume controls. You can set the volume in two places: in software and on the speakers.

Speakers

The second place to look for sound problems is the speakers. Make sure that the speakers are turned on and are getting good power. Then make sure the speakers are plugged into the proper connection on the back of the sound card. If this all checks out, try playing a sound using any sound program. If the sound program looks like it is playing maybe the application has an equalizer that is moving or a status marker that shows that the application is playing the sound you may have blown speakers. Try another pair and see if the sound returns.

Most of the time, speakers come in a matched set whether or other system and the manufacturer will include adequate connecting wires for the whole set. On circumstance, you might run into a system in which the user has connected pairs of speakers from different sets or rigged a surround sound system by replacing the stock wires with much longer wires. Either option can create a perfectly functional surround sound system that works for a specific room, but you should make sure that all the speakers match in wattage required and that high-quality wire is used to connect them.

If you troubleshoot a system in which two of the speakers are very quiet and two very loud, the wattages are probably different between the two pairs. A simple check of the labels should suffice to troubleshoot, or you can swap out one pair for a different pair and see if that affects the volume issues. Cheap wire, on the other hand, simply degrades the sound quality. If the speakers sounded good before getting strung on long wires, but they now have a lot of low grade noise, blame the wires.

Keyword

Device Manager: It is a control panel applet in Microsoft Windows operating systems and allows users to view and control the hardware attached to the computer.

Configuration Problems

Configuration errors occur when the sound card is physically good but some setting has not been properly configured. These errors happen almost exclusively at installation, but they can appear on a working system, too.

The first place to check is the **device manager**. If the driver has a problem, you shall see it right there. Try reinstalling the driver. If the driver does not show any problems, again try playing a sound and see if the player acts as though the sound is playing. If you need to start touring the Sounds and Audio Devices applet to see if you have made a configuration error perhaps you have the system configured when you have a stereo setup, or maybe you set the default sound output device to some other device. Take time and look configuration errors always show themselves.

Application Problems

Application problems are always the hardest to fix and tend to occur on a system that was previously playing sounds without trouble. First, look for an error message. If an error code appears, write it down exactly as you see it and head to the program's support site. Odds are very good that if you have the error text, you shall get the fix right away from the support site. Of course, you can always hope the built-in help has some support, but help systems tend to be a little light in providing real fixes.

5.2 VIDEO

The term video encompasses a complex interaction among numerous parts of the PC, all designed to put a picture on the screen. The monitor shows you what is going on with programs and operating system. It is the primary output device for the PC. The video card or display adapter handles all of the communication between the CPU and the monitor. The operating system needs to know how to handle communication between the CPU and the display adapter, which requires driver's specific for each card and proper setup within Windows. Finally, each application needs to be able to interact with the rest of the video system.

To understand video displays, you need a good grasp of the components and how they work together to make a beautiful (or not so beautiful) picture on the screen. Different types of displays use different methods and technologies to accomplish this task. Video displays for PCs come in three varieties: CRT, LCD, and projectors. The first two you shall see on the desktop or laptop; the last you shall find in boardrooms and classrooms, splashing a picture onto a screen.

5.2.1 Selecting the Right Monitor

Choosing the right computer monitor may seem like a daunting task. While the average consumer is often focused on price point alone, the fact that "you get what you pay for" still holds true.

When it comes to choosing the right monitor, there are some factors to consider:

- Price
- Size
- Resolution
- Viewing Angles
- Contrast Ratio
- Color Quality & Color Gamut
- Brightness
- Response Time & Processing Lag
- Video Inputs
- Monitor Stand and Adjustments

REMEMBER

The monitors for a multimedia application must be high-end, large screen graphics monitor and liquid crystal display.

Price

If consumers are buying panels based on their needs, then the truth is that most people are out to get the biggest display for price. For most consumers, size does matter and big monitors are no exception. Many people cannot tell the difference in picture quality if the monitors are not side by side. That being said, if picture quality does not matter as much as size, which is what the market is geared to deliver based on demand, then you can expect to pay the prices below. Monitors at these prices will suffice for most people and will meet their expectations for quality and features.

Size and Resolution

These often go hand in hand and there are a number of common resolutions for the various monitor sizes offered. All LCD panels are measured diagonally from corner to corner, which consists of the entire viewing space. This is different from CRTs which are measured by the size of their tube, which is partially obscured by the bezel. That is why a 32″ CRT television display only measures about 30″ diagonally but you probably do not have to worry about that anymore.

Monitor Resolutions

The monitor resolution of a computer monitor or display device is the number of distinct pixels in each dimension that can be displayed. It can be an ambiguous term especially as the displayed resolution is controlled by different factors in cathode ray tube (CRT), flat-panel display which includes liquid-crystal displays, or projection displays using fixed picture-element (pixel) arrays.

Keyword

Contrast Ratio: It is a property of a display system, defined as the ratio of the luminance of the brightest color.

Viewing Angles

These are the horizontal and vertical fields of view where the display's image appears acceptable. Typically viewing angles are poor with Twisted Nematic (TN) panels, which make up the majority of monitor panels. 160/170 degree horizontal and 160 degree vertical viewing angles are typical with TN panels, whereas 178 degrees horizontal and vertical can be found in nearly all in-plane switching (IPS), multi-domain vertical alignment (MVA) and patterned vertical alignment (PVA) panels. TN panels are bottom barrel and mediocre viewing angles are just one of their weaknesses. TN technology's greatest success is that it is cheap, and since the market is driven by the demand for dime-a-dozen monitors with little regard to quality, TN displays are plentiful.

Contrast Ratio

Contrast ratio refers to the ratio of the lightest color (white) to the darkest color (black) that the monitor is capable of displaying. Traditionally panels were rated based on their static contrast (the ratio above), but the recent implementation of dynamic contrast has created some confusion for the consumer. Dynamic contrast (DC) used in LCD displays is a method to artificially increase the contrast by lowering the backlight when a dark image is displayed on the screen.

Brightness

All modern monitors have more than enough brightness for all indoor lighting conditions, which is why this should not be a deciding factor.

Color Quality and Color Gamut

A monitor's color gamut is the range of colors that it can display accurately and is largely dependent on the backlighting. NTSC and Adobe RGB 1998 color gamut's are common profiles used to rate a monitor's color gamut in the coverage of a color space chromaticity.

Processing Lag and Response Time

Video Inputs

There are a number of inputs commonly found on LCD monitors and almost all will be equipped with a DVI input and often a VGA input as well. There are some outliers that only have an HDMI input, *for example*, so keep eye out. While you likely only need a DVI port, more inputs will give the monitor versatility when connecting to different devices.

Monitor Stand and Adjustments

Would you buy a car without adjustable seats? May be if it saved you some cash. A stand with proper monitor adjustments can make the difference between viewing the screen comfortably and well not.

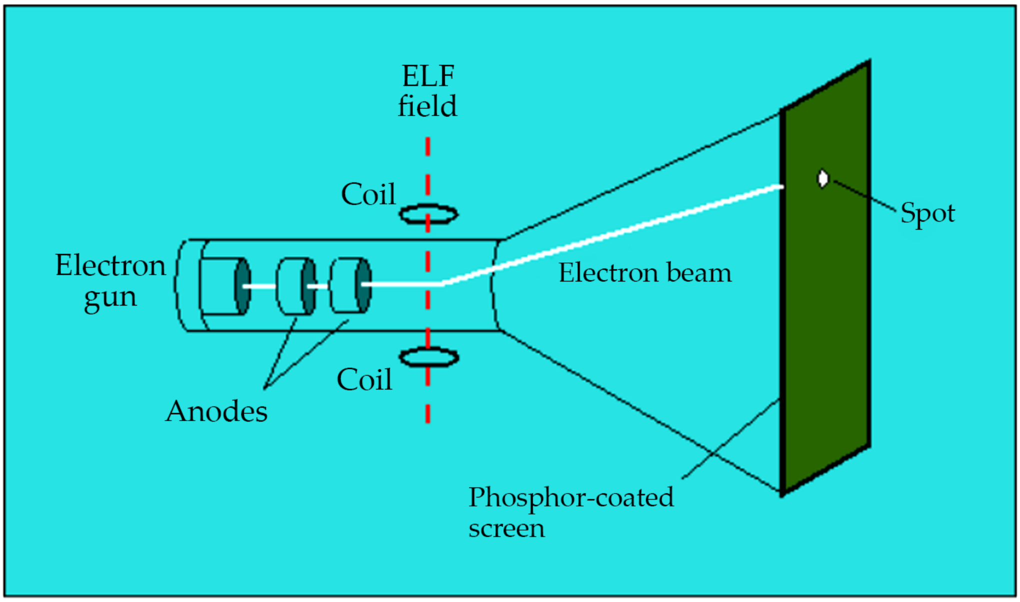
Keyword

Electromagnetic fields are a combination of invisible electric and magnetic fields of force. They are generated by natural phenomena like the Earth's magnetic field but also by human activities, mainly through the use of electricity.

5.3 SPECIFICATION OF CRT

A cathode ray tube (CRT) is a specialized vacuum tube in which images are produced when an electron beam strikes a phosphorescent surface. Most desktop computer displays make use of CRTs. The CRT in a computer display is similar to the "picture tube" in a television receiver.

A cathode ray tube consists of several basic components. The electron gun generates an arrow beam of electrons. The anodes accelerate the electrons. Deflecting coils produce an extremely low frequency **electromagnetic field** that allows for constant adjustment of the direction of the electron beam. There are two sets of deflecting coils: horizontal and vertical. The intensity of the beam can be varied. The electron beam produces a tiny, bright visible spot when it strikes the phosphor-coated screen.



To produce an image on the screen, complex signals are applied to the deflecting coils, and also to the apparatus that controls the intensity of the electron beam. This causes the spot to race across the screen from right to left, and from top to bottom, in a sequence of horizontal lines called the raster. As viewed from the front of the CRT, the spot moves in a pattern similar to the way eyes move when you read a single-column page of text. But the scanning takes place at such a rapid rate that eye sees a constant image over the entire screen.

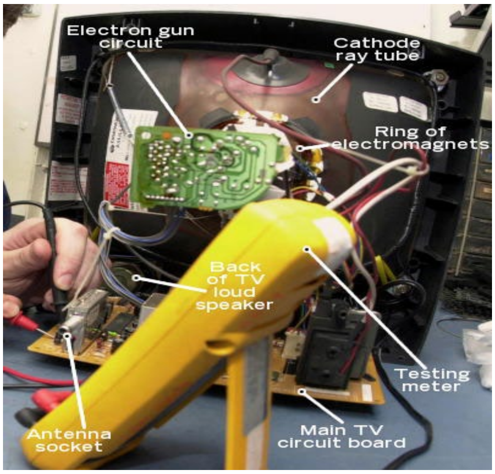
However, virtually all CRTs today render color images. These devices have three electron guns, one for the primary color red, one for the primary color green, and one for the primary color blue. The CRT thus produces three overlapping images: one in red (R), one in green (G), and one in blue (B). This is the so-called RGB color model.

In computer systems, there are several display modes, or sets of specifications according to which the CRT operates. The most common specification for CRT displays is known as SVGA (Super Video Graphics Array). Notebook computers typically use liquid crystal display. The technology for these displays is much different than that for CRTs.

5.3.1 How CRTs work

A step-by-step diagram showing how three scanning electron beams draw the picture inside a cathode-ray tube CRT working:

- An antenna (aerial) on the roof picks up radio waves from the transmitter. With satellite TV, the signals come from a satellite dish mounted on the wall or roof. With cable TV, the signal comes to you via an underground fiber-optic cable.
- The incoming signal feeds into the antenna socket on the back of the TV.
- The incoming signal is carrying picture and sound for more than one station (program). An electronic circuit inside the TV selects only the station you want to watch and splits the signal for this station into separate audio (sound) and video (picture) information, passing each to a separate circuit for further processing.
- The electron gun circuit splits the video part of the signal into separate red, blue, and green signals to drive the three electron guns.
- Someone testing and repairing a TV set.
- The circuit fires three electron guns (one red, one blue, and one green) down a cathode-ray tube, like a fat glass bottle from which the air has been removed.
- The electron beams pass through a ring of electromagnets. Electrons can be steered by magnets because they have a negative electrical charge. The electromagnets steer the electron beams so they sweep back and forth across the screen, line by line.
- The electron beams pass through a grid of holes called a mask, which directs them so they hit exact places on the TV screen. Where the beams hit the phosphors (colored chemicals) on the screen, they make red, blue, or green dots. Elsewhere, the screen remains dark. The pattern of red, blue, and green dots builds up a colored picture very quickly.
- Meanwhile, audio (sound) information from the incoming signal passes to a separate audio circuit.
- The audio circuit drives the loudspeaker (or loudspeakers, since there are at least two in a stereo TV) so they recreate the sound exactly in time with the moving picture.



5.4 LCDS

Liquid crystal displays (LCD) are a type of flat monitor device that renders an image by using sandwiched layers of glass, electrodes, and liquid crystals (LCs). These LCs are physically liquid, though they also display a number of crystal-like properties in the way the molecules are arranged. The unique properties of LCs allow them to change alignment in a predictable way when an electrical current is introduced. This can be used in a liquid crystal display to activate discrete, monochrome patterns like in a clock radio, or tiny pixels in a high resolution computer monitor or television. Liquid crystal displays are found in items ranging from watches to cellular phones and laptop computers.

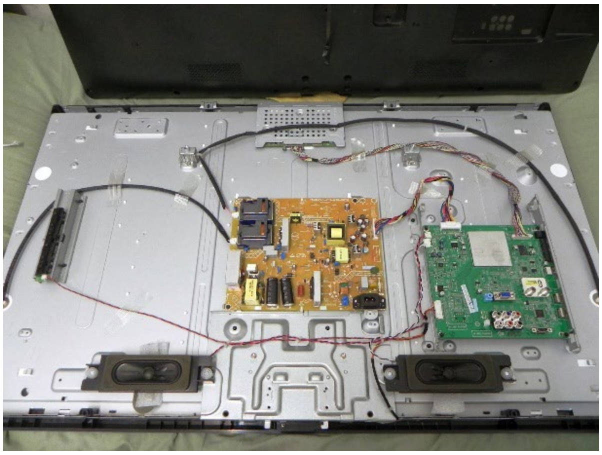
Each liquid crystal display can consist of a number of different components. There is typically a layer of LCs that is sandwiched between the electronics necessary to activate them, one or more layers of glass, and polarizers or reflectors. LCDs that rely on outside light will typically have a reflector as the back layer so that light can pass through the LCs and return to the eyes of a viewer. Other liquid crystal displays use a backlight instead of a reflector so that the device requires no external light source. Polarizing layers are typically necessary due to the way that LCs rotates to block light or allow it through.

The simplest form of liquid crystal display uses a type of passive matrix. These displays have individual electrical connections for each discrete of LCs, which is effective when dealing with the few elements found in devices such as clock radios, calculators, and watches. More complex LCDs can also use passive matrix displays, though the technology becomes less efficient as more elements are added in. Early laptop screens made use of passive matrix LCDs, though active matrix technology took over in the mid-1990s.

A liquid crystal display that uses an active matrix can employ one of about five different technologies to create a visible image. Each of these different active matrix technologies use thin film transistors (TFTs) to energize each individual pixel in the display. Some active matrix LCDs also uses diodes and other components, though they all use TFTs to create a sharper, more responsive image. Since the active matrix technology allows for faster refresh rates, sharper images, and better colors, this type of liquid crystal display is found in a variety of applications including flat screen televisions, laptops, and cellular phones. Many TFT LCDs also incorporate a specialized layer that can turn them into touchscreen displays. An LCD monitor is a thin, light computer monitor that displays images through the use of a liquid crystal display. LCD screens are found in most laptop computers as well as in flat panel monitors, and have replaced traditional cathode ray tube (CRT) monitors for many users. CRTs once were preferred by many users for their superior color presentation; improvements in LCDs have made the difference less noticeable, but still important to graphics and photography professionals and serious amateurs.

Inside the LCD

A color monitor is typically made up of five layers: a backlight, a sheet of polarized glass, a mask of colored pixels, a grid layer of responsive liquid crystal solution, and a second polarized sheet of glass. Images are created manipulating the orientation of the crystals through precise electrical charges of varying degrees and voltages. They act like tiny shutters, opening or closing in response to the stimulus, thereby allowing degrees of light that have passed through specific colored pixels to illuminate the screen.



As LCD technology has evolved, different techniques for producing color have emerged. Passive matrix screens, which were the first invented, use two transistors one for each row and one for each column of pixels to activate a particular point on the LCD grid. Active-matrix screens usually use thin film transistor (TFT) technology, in which each point on the grid has its own transistor; this allows only the desired pixels to be activated. Passive matrix screens tend to respond more slowly than active matrix screens, and are not able to produce the same level of image quality.

Monitor Specifications

Most modern LCD computer monitors use active matrix technology. Within this group, there are a number of specifications that set one LCD monitor apart from another. Size, aspect ratio, and resolution are three related features; contrast ratio, brightness, viewing angle, and response time are also important.

The size of an LCD monitor can affect its price, resolution, and aspect ratio. Larger monitors are more expensive; the transistors that are used to make active matrix displays have a high failure rate, and since bigger monitors have more transistors, consumers are paying in part for those that are defective and cannot be sold. Aspect ratio refers to the shape of the screen, with standard screens usually having a 4:3 or 5:4 ratios. Widescreen monitors tend to be bigger, but allow images to be viewed in a 16:9 (or 16:10) aspect ratio.

A bigger screen may also allow for a higher native resolution, or the number of pixels it can display. A screen with a high native resolution will be very sharp, and be able to display more information than one with a lower resolution can. Most monitors can display resolutions other than what is native, but the image may appear blurry.

Contrast ratio relates to the display's comparative difference between its brightest white values and its darkest black. A higher contrast ratio will have truer colors with fewer washouts, and allow for a greater range of shades. The standard offering for lower-end models is commonly 350:1, but many experts recommend a contrast ratio of 500:1 or better.

LCD monitors tend to be bright, with standard levels being more than adequate for everyday use. Brightness is measured in nits, units of one candela per square meter. Anywhere from 250 to 300 nits is standard, although people who play games may benefit from a brighter screen. If the nits are much higher, the user will likely end up adjusting the brightness down for regular use.

The vertical and horizontal viewing angle specifications refer to the degree the viewer can stray from dead center before the picture starts to wash out. Most monitors are looked at straight-on, but wider angles can benefit people who use multiple screens, or if the screen will be used by several people at one time. Many experts recommend a viewing angle of at least 140° horizontal and 120° vertical, but the wider the viewing angles, the better.

Response time is measured in milliseconds and refers to how long it takes pixels to turn from completely white to black and back again. Smaller values represent a faster response time and are more desirable, especially for playing games and viewing videos. If the response time is slow, ghosting or trailing can occur with fast-moving images, where images linger as the screen refreshes. A maximum response time should be no more than 25 ms for general use, and 17 ms is better. Many gamers report no ghosting using an LCD monitor with a response time of 16 ms or less.

Advantages and Disadvantages

Advantages

- One major advantage of LCD monitors is their size; they are commonly 1 to 3 inches (2.5 to 7.5 cm) thick and weigh less than 10 pounds (4.5 k). CRT monitors, on the other hand, have a depth five times as large, and a weight of 30 to 50 pounds (13 to 23 kilograms) or more. As such, LCDs can take up 90% less space, and are far easier to move or adjust.
- A wide variety of screen sizes are available, from 15 to 30 inches (38.1 to 76.2 cm) or larger. For average sizes 22 to 24 inches (55.88 to 60.96 cm) the price of an LCD monitor is about the same as a traditional CRT. LCD screens tend to last longer, however; in addition, if a few pixels on the screen fail, the monitor is still usable.
- LCDs use relatively little electricity, especially when compared to their CRT counterparts, and produce far less heat. They also emit very low levels of electromagnetic radiation. LCD monitors are also easier on the eyes; glossy or matte screens are usually available, and matte screens reduce glare.

Disadvantages

- LCD monitors have largely displaced CRTs in most monitors, except for very cheap and very expensive models. CRTs still can offer better color content and depth at the high end, and also have the advantage of multi sync, or the ability to keep colors consistent even when a picture's resolution is changed. Colors on LCDs may also change hue as the viewer moves to the outer limits of the viewing angle, particularly on displays with narrow viewing angles and low contrast ratios. Graphics, photography, and design professionals, as well as medical professionals, usually have preferred CRT monitors for these advantages.
- A potential weak link of an LCD monitor is the backlight. Since the liquid crystals do not produce any light on their own, if the backlight fails, the monitor is unusable. Many monitors come with a three-year warranty, but stipulate one year for the backlight.

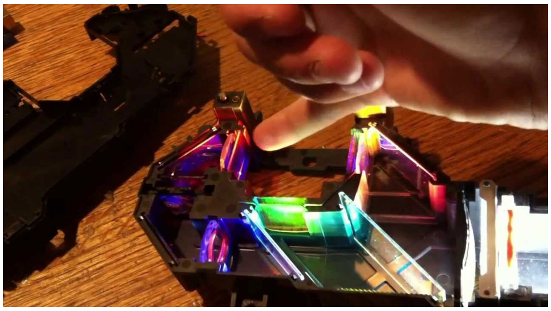
REMEMBER

The chemical formula of the liquid crystals used in LCDs may vary. Formulas may be patented. An example is a mixture of 2-(4-alkoxyphenyl)-5-alkylpyrimidine with cyanobiphenyl, patented by Merck and Sharp Corporation. The patent that covered that specific mixure expired.

5.4.1 How LCDs Work

The secret to understanding LCD panels is to understand the concept of the polarity of light. Anyone who played with a prism in sixth grade or looked at a rainbow knows that light travels in waves and the wavelength of the light determines the color. What you might not appreciate is the fact that light waves emanate from a light source in three dimensions. It is impossible to draw a clear diagram of three-dimensional waves, so instead, let us use an analogy. To visualize this, think of light emanating from a flashlight. Now think of the light emanating from that flashlight as though someone was shaking a jump rope. This is not a rhythmic shaking, back and forth or up and down; it is more as if a person went crazy and was shaking the jump rope all over the place up, down, left, right constantly changing the speed.

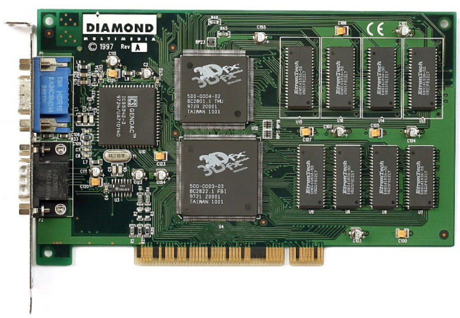
When light comes into eyes at many different wavelengths, you see white light. If the light came in only one wavelength, you would see only that color. Light flowing through a polarized filter is like putting a picket fence between you and the people shaking the ropes. You see all of the wavelengths, but only the waves of similar orientation. You would still see all of the colors, just fewer of them because you only see the waves of the same orientation, making the image darker. That is why many sunglasses use polarizing filters.



Liquid crystals take advantage of the property of polarization. Liquid crystals are composed of a specially formulated liquid full of long, thin crystals that always want to orient themselves in the same direction. This substance acts exactly like a liquid polarized filter. If you poured a thin film of this stuff between two sheets of glass, you did get a darn good pair of sunglasses.

5.4.2 Graphics Processor

The graphics processor handles the heavy lifting of taking commands from the CPU and translating them into coordinates and color information that the monitor understands and displays. Many companies make the hundreds of different video cards on the market, but only two companies pro-duce the vast majority of graphics processors found on video cards: NVIDIA and All NVIDIA and ATI make and sell graphics processors to third-party manufacturers who then design, build, and sell video cards under their own branding. ATI also makes and sells its own line of cards. Figure shows an NVIDIA GeForce 7900 cr. KO on a board made by EVGA. The choice of graphics processor is the single most important decision in buying a video card. Low-end graphics processors will usually work fine for the run-of-the-mill user who wants to write letters or run.



A Web browser. High end graphics processors are designed to support the beautiful 3-D games that are so popular today. NVIDIA and All are extremely competitive, and both companies intro-duce multiple models of graphics processors (and therefore new models of cards) every year. However, unless you are using the Vista Aero glass desktop, all of these extra features you see in video cards are really only for the true driving force in video cards: 3-D gaming. PC is capable of providing you with hours of incredible entertainment via a huge number of popular games that immerse you in 3-D environments full of light, shadows, explosions, and other amazing effects that create a fun and beautiful gaming experience. These 3-D games have special needs to do all this amazing stuff. One need is textures. A texture is a small picture that is tiled over and over again on walls, floors, and other surfaces to create the 3-1) world. It is made up of only three textures that are repeated over and over again on the surface. Games also use hundreds of lighting effects such as transparency (water), shadows, reflection, and bump mapping the process of laying multiple textures on the same spot to give a more textured (bumpy) look to the surface.

5.5 VIDEO RAM

Video RAM (VRAM) means in general all forms of random access memory (RAM) used to store image data for a computer display. All types of video RAM are special arrangements of dynamic RAM (DRAM). Video RAM is really a buffer between the computer processor and the display and is often called the frame buffer. When images are to be sent to the display, they are first read by the processor as data from some form of main (non-video) RAM and then written to video RAM. From video RAM (the frame buffer), the data is converted by a RAM digital-to-analog converter (RAMDAC) into analog signals that are sent to the display presentation mechanism such as a cathode ray tube (CRT). Usually, video RAM comes in a 1 or 2 megabyte package and is located on the video adapter card in the computer. Most forms of video RAM are dual-ported, which means that while the processor is writing a new image to video RAM, the display is reading from video RAM to refresh its current display content. The dual-port design is the main difference between main RAM and video RAM.

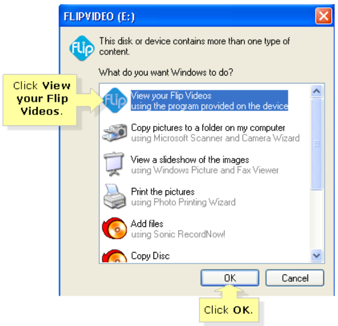
Somewhat confusingly, the most common type of video RAM is called Video RAM (VRAM).Video RAM is the vanilla flavor of video RAM. It is dual-ported, allowing the processor to write to it at the same time that it is refreshing the image on the display monitor. Other forms of video RAM include:

- Synchronous Graphics RAM (SGRAM) is clock-synchronized RAM that is used for video memory. It is relatively low-cost video memory. It uses masked write, which enables selected data to be modified in a single operation rather than as a sequence of read, update, and write operations. It also uses block write, which allows data for background or foreground image fills to be handled more efficiently. SGRAM is single-ported. Its special features are what make it a moderately fast form of video memory. The Matrox Mystique is an example of a video card that uses SGRAM.
- Window RAM (WRAM), unrelated to Microsoft Windows, is very high-performance video RAM that is dual-ported and has about 25% more bandwidth than VRAM but costs less. It has features that make it more efficient to read data for use in block fills and text drawing. It can be used for very high resolution (such as 1600 by 1200 pixels) using true color. It is used in the Matrox Millenium video card.
- Multibank Dynamic RAM (MDRAM) is a high-performance RAM, developed by MoSys, that divides memory into multiple 32 kilobytes parts or "banks" that can be accessed individually. Traditional video RAM is monolithic; the entire frame buffer is accessed at one time. Having individual memory banks allows accesses to be interleaved concurrently, increasing overall performance. It is also cheaper since, unlike other forms of video RAM, cards can be manufactured with just the right amount of RAM for a given resolution capability instead of requiring it to be in multiples of megabytes.
- Rambus Dynamic RAM (DRAM) is a video RAM designed by Rambus that includes a proprietary bus that speeds up the data flow between video RAM and the frame buffer. It is optimized for video streaming.

5.5.1 Installing and Configuring Video Software

How to install Flip-Share on my Computer with my Flip video Camera for Windows XP

Step 1: Plug in the Flip Video Camera into the computer's USB 2.0 port. On the pop-up window that will appear on the screen, select the View the flip videos option then click OK.



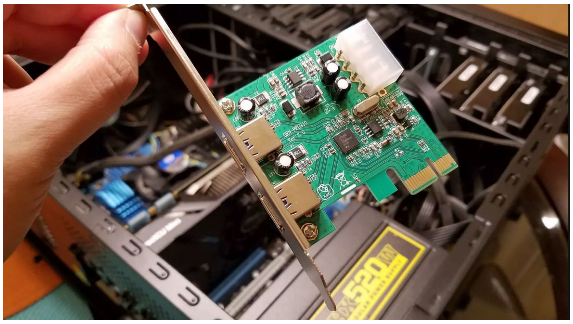
Step 2: The Flip-Share splash screen window will appear. Click the License Agreement at the bottom and read through it. Check the box I have read and accept the term of the License Agreement then click Install.

The progress of the installation will be indicated at the lower left portion of the window. You will know if the installation is successful when the progress bar is already full.

After the installation, the Flip-Share window will appear on the screen. You will find all the recorded videos in the Workspace.

5.6 TROUBLESHOOT MONITOR AND VIDEO CARD PROBLEMS

Display problems are among the most common difficulties people have when upgrading either Windows or their computers. Here are solutions to some common display problems. You can also try running a troubleshooter to diagnose and fix common problems with Windows Aero, which can cause display problems.



How do You Determine what is causing my Display Problem?

The computer's display consists of two pieces of hardware: a video card (also known as a graphics card or display adapter), which is installed inside the computer, and the video monitor, where you see all the text and graphics the programs display. Windows uses drivers to work with these hardware devices. The majority of display problems are caused by incorrect, corrupted, or missing video drivers. Hardware failure or incorrect installation make up another set of problems, and external factors can also cause video problems.

If you have just installed Windows, or have changed the video card and are experiencing problems, the most likely cause is a missing or incorrect video driver. Most video cards will come with a disk that contains drivers and other software. Before you install it, check the information that came with the video card to be sure it supports the current version of Windows. If not, go to the manufacturer's website and download the most current driver for the version of Windows.

How do You Find Out what Kind of Video Card my Computer has?

Open Display Settings by clicking the Start button Picture of the Start button, clicking Control Panel, clicking Appearance and Personalization, clicking Personalization, and then clicking Display Settings. This is where you can find out what kind of video card and monitor the computer has. For more information on video cards, see Video cards: frequently asked questions.

What Kind of Monitor do you have?

There are two basic types of monitors: CRT (cathode ray tube) monitors and LCD (liquid crystal display) monitors. Both types produce sharp images, but LCD monitors have the advantage of being much thinner and lighter. CRT monitors are larger, heavier, require more desk space, and produce more heat than LCD models. If you need to update the Windows device driver for the monitor, you shall need to know the brand and model, which is usually printed on a label on the back or bottom of the monitor.

Why does my Monitor Show only Limited Resolutions?

When Windows is installed, it attempts to identify the hardware it is installed on. By default, if it does not recognize the video card in the computer, Windows will install a generic video driver. This generic driver usually does not provide the same level of support as a driver written specifically for the video card. To fix this problem, you need to install the correct driver for the video card. Go to the video card manufacturer's website to download a driver. You shall need to know the make and model of the video card. For more information on installing drivers, see Update a driver for hardware that is not working properly.

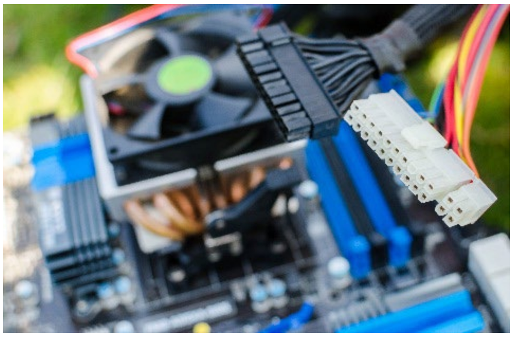
Why are you Seeing Horizontal Lines, Flickering, or other Strange Interference on the Screen of my CRT Monitor?

CRT monitors are often more prone to outside interference than LCD monitors. Interference can be caused by devices that transmit radio frequencies (RF) (such as a baby monitor or CB radio), or devices that produce magnetic fields (such as a motor in an electric fan), or even by just having a tangle of power cables on or near the monitor.Radio signals can interfere with the signal going between the computer and monitor, and can cause horizontal lines to appear, as well as other interference. To reduce interference, move the RF device away from the computer, or move the computer and monitor away from the device.

Moving magnetic fields (such as from an electric motor) can cause flickering when near a CRT screen. A static magnetic field, such as from the computer's speakers, can cause color shifts or incorrect colors in the area near the magnet. This color shift is caused by parts of the screen becoming magnetized. Occasionally the color shift will remain after you remove the source of magnetism. To help reduce or eliminate the color shift, you can use the degaussing option on most monitors. Most new monitors automatically degauss when you turn them on, while older monitors might require you do to it manually. Most monitors have a button or menu option that enables you to degauss it manually. Degaussing a monitor will de-magnetize the inside of the monitor, removing the color shift. Unfortunately, if the monitor is exposed to the source of magnetism for too long, degaussing will not be able to clear it up, requiring you to repair or replace the monitor.

What is DirectX and how can you Troubleshoot it?

DirectX is a Windows technology that includes video, animation, and sound features, which help the computer, get more performance out of multimedia programs such as games and movies. The DirectX Diagnostic Tool is designed to help you troubleshoot DirectX-related issues. This tool can give you information about the system, such as memory and processor speed, as well as the installed version of DirectX, and whether it is operating correctly. For more information on DirectX, see DirectX: frequently asked questions. To use the DirectX Diagnostic Tool, see Run DirectX Diagnostic Tool.



You have changed the Resolution of my Monitor, and now you cannot see the Display

Most video monitors have a specific range of resolution they can display. If you specify a value outside that range, it can cause the monitor to display incorrectly, or not at all. Normally when you change resolution, Windows will wait a short time for you to confirm that you want to keep the resolution. If you do not confirm, Windows will change the resolution back to its previous value. However, if you accidently confirm it, but the monitor cannot display the new resolution, you will need to restart Windows in Safe Mode and reset the resolution to one that can be displayed by the monitor. For more information, see Change screen resolution.

Why does the Text on my Monitor Appear Blurry?

Windows uses a technology called clear type to create more readable text on screen. On some monitors, you might want to turn clear type on or off, or need to adjust it. For more information on turning on and adjusting clear type, see Make text easier to read using clear type. For detailed information on using clear type, see clear type: frequently asked questions.

How do you set up Multiple Monitors?

Using two or more monitors on the computer can enhance the experience with using video games, spreadsheets, image-editing programs, or anything else that benefits from a larger screen size. For more information on installing additional monitors, search Help and Support for "multiple monitors."

Why do you get an Error when you use different Video Cards for Multiple Monitors?

Windows Vista uses the new, more stable **Windows Display Driver Model** (WDDM), which does not allow you to use more than one video driver when you use multiple monitors on a computer. Errors usually occur when you have more than one video card from different manufacturers, including any video support built into the motherboard on the computer.

To use multi-monitor support with more than one video card, all the cards must use the same driver. This usually means using the same video card, or different cards from the same manufacturer (provided that they use the same driver). Most new video cards enable you to set up two monitors using the single video card, so you do not have to use more than one card for two monitors. For more information on using the video card, go to the manufacturer's website. For more information on using multiple monitors, search Help and Support for multiple monitors.

Change the Brightness and Contrast of my Monitor

You can adjust the brightness and contrast of the monitor to improve the readability of text and images.

SUMMARY

- Sound, any disturbance that travels through an elastic medium such as air, ground, or water to be heard by the human ear. When a body vibrates, or moves back and forth, the oscillation causes a periodic disturbance of the surrounding air or other medium that radiates outward in straight lines in the form of a pressure wave.
- Video codecs will contain a sequence of frames, i.e. still pictures and, for compressed formats, movements between those pictures. Quality will vary depending on the number of frames per second, color space, resolution, etc.
- Audio and video are used for enhancing the experience with Web pages (e.g. audio background) to serving music, family videos, presentations, etc.
- Sound is a mechanical disturbance from a state of equilibrium that propagates through an elastic material medium.
- Sound propagates through air or other mediums as a longitudinal wave, in which the mechanical vibration constituting the wave occurs along the direction of propagation of the wave.
- The speed of sound in air varies with pressure and temperature, with higher pressures and temperatures giving higher speeds.
- The pitch of a sound depends on the frequency, with higher pitches having higher frequencies. The amplitude is the height of the waves and describes the amount of energy carried. High amplitudes have higher volumes.
- Sound waves have many applications in science and medicine. Ultrasound imaging can be used to investigate medical problems and carry out important checks. One well-known application is an ultrasound scan, used to produce an image of an unborn child, in order to check on its health where an X-ray would not be safe.

KNOWLEDGE CHECK

1. A video consists of a sequence of

a. Frames

b. Signals

c. Packets

d. Slots

2. Most common compression technique that is used to create CD-quality audio is based on perceptual encoding technique is called

a. Predictive Encoding

b. Perceptual Encoding

c. MPEG

d. JPEG

3. MIDI stands for:

a. Musical Instrument Digital Interface

b. Musical Instrument Digital Instruction

c. MP3 Instrument Digital Interface

d. Musical Instrument Design Interface

e. Multimedia Instrument Digital Interface.

4. In Audio and Video Compression, each frame is divided into small grids, called picture elements or

a. Frame

b. Packets

c. Pixels

d. Mega Pixels

5. If frames are displayed on screen fast enough, we get an impression of

a. Signals

b. Motions

c. Packets

d. Bits

6. We have to be sure that is connected to the computer before recording anything.

a. Speaker and Microphone

b. Speaker and Printer

c. Microphone and Web camera

d. Speaker and Micro pen

7. ....program is available before recording the sound.

a. Voice Recorder

b. Sound Recorder

c. Audio Recorder

d. Wave Recorder

8. Streaming stored audio/video, the files are compressed and stored on a

a. IP

b. server

c. domain

d. internet

REVIEW QUESTIONS

1. What do you understand by the sound and video?
2. Explain how sound works in a PC.
3. Discuss about the musical instrument digital interface (MIDI).
4. Define how to install a sound card in a windows system.
5. What do you mean by the troubleshooting sound?
6. Discuss about the CRTs and LCDs.
7. Explain the working of the CRTs and LCDs.
8. Describe the graphics processor.

Check Your Result

1. (a) 2. (b) 3. (a) 4. (c) 5. (b)

6. (a) 7. (b) 8. (b)

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CHAPTER 6

INPUT DEVICES

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Explain keyboard
2. Troubleshoot the connection: DIN, USB, and Wireless
3. Define the mouse

"Reality exists in the mind of each. The senses are input devices for incoming data."

— ***Toba Beta***

INTRODUCTION

Input device enables the user to send data, information, or control signals to a computer. The Central Processing Unit (CPU) of a computer receives the input and processes it to produce the output.

An input device is any device that provides input to a computer. There are dozens of possible input devices, but the two most common ones are a keyboard and mouse. Every key press on the keyboard and every movement or click make with the mouse sends a specific input signal to the computer. These commands allow to open programs, type messages, drag objects, and perform many other functions on computer.

An input device is a piece of equipment used to provide data and control signals to an information processing system such as a computer or information appliance. Examples of input devices include keyboards, mouse, scanners, cameras, joysticks, and microphones.

Input devices can be categorized based on:

- Modality of input (e.g., mechanical motion, audio, visual, etc.)
- Whether the input is discrete (e.g., pressing of key) or continuous (e.g., a mouse's position, though digitized into a discrete quantity, is fast enough to be considered continuous)
- The number of degrees of freedom involved (e.g., two-dimensional traditional mice, or three-dimensional navigators designed for cad applications)

Traditional keyboards use spring-based buttons, though newer variations employ. There also happens to be another keyboard that is like an input device for musical instrument which helps to produce sound.

Keyword

Keyboard: External input device used to type data into some sort of computer system whether it is a mobile device, a personal computer, or another electronic machine.

6.1 KEYBOARD

It is the piece of computer hardware used to input text, characters and other commands into a computer or similar device.

Keyboard is basically a board of keys. Along with the mouse, the keyboard is one of the primary input devices used with a computer. The keyboard's design comes from the original typewriter keyboards, which arranged letters and numbers in a way that prevented the type-bars from getting jammed when typing quickly. This keyboard layout is known as the QWERTY design, which gets its name from the first six letters across in the upper-left-hand corner of the keyboard.

While the design of computer keyboards may have come from typewriters, today's keyboards have many other keys as well. Modifier keys, such as Control, Alt/Option, and Command (Mac) or the Windows key (Windows) can be used in conjunction with other keys as "shortcuts" to perform certain operations.

For example, pressing Command-S (Mac), or Control-S (Windows) typically saves a document or project are working on. Most of today's computer keyboards also have a row of function keys (F1 through F16) along the top of the keyboard, arrow keys arranged in an upside-down T, and a numeric keypad on the right-hand side. Some keyboards have even more buttons, allowing to change the system volume, eject a CD, or open programs such as e-mail or Web browser.

The computer keyboard uses the same key arrangement as the mechanical and electronic typewriter keyboards that preceded the computer. The standard arrangement of alphabetic keys is known as the QWERTY (pronounced KWEHR-tee) keyboard, its name deriving from the arrangement of the five keys at the upper left of the three rows of alphabetic keys. This arrangement, invented for one of the earliest mechanical typewriters, dates back to the 1870s. Another well-known key arrangement is the Dvorak (pronounced duh-VOR-ak, not like the Czech composer) system, which was designed to be easier to learn and use. The Dvorak keyboard was designed with the most common consonants on one side of the middle or home row and the vowels on the other side so that typing tends to alternate key strokes back and forth between hands. Although the Dvorak keyboard has never been widely used, it has adherents.

REMEMBER

The minimum horizontal surface width for a key on a typing keyboard should be 12 mm.

When talking to tech support or to other people about keyboard commands, web pages, and command line commands, may hear such things as forward slash, backward slash, and caret. Many times this can be confusing for anyone unfamiliar with each of the symbols on a keyboard. The helps identify each non-alphanumeric keyboard key and a short description of the key or a link to a page with information about the key.

Symbol	Explanation
Windows	PC keyboards have a Windows key, which looks like a four-pane window
Command	Apple Mac computers have a command key.
Esc	Esc (Escape) key
F1 - F12	Information about the F1 through F12 keyboard keys.
Tab	Tab key
Caps lock	Caps lock key
Shift	Shift key
Ctrl	Ctrl (Control) key
Fn	Fn (Function) key
Alt	Alt (Alternate) key (PC Only; Mac users have Option key)
Spacebar	Spacebar key
Arrows	Up, Down, Left, Right Arrow keys
Back Space	Back space (or Backspace) key
Delete	Delete or Del key
Enter	Enter key
Prt Scrn	Print screen key
Scroll lock	Scroll lock key
Pause	Pause key
Break	Break key
Insert	Insert key
Home	Home key
Page up	Page up or pgup key
Page down	Page down or pgdn key
End	End key
Num Lock	Num Lock key
~	Tilde
`	Acute, Back quote, grave, grave accent, left quote, open quote, or a push
!	Exclamation mark, Exclamation point, or Bang
@	Ampersat, Arobase, Asperand, At, or At symbol

#	Octothorpe, Number, Pound, sharp, or Hash
£	Pounds Sterling or Pound symbol
€	Euro
$	Dollar sign or generic currency
¢	Cent sign
¥	Chinese Yuan
§	Micro or Section
%	Percent
°	Degree
^	Caret or Circumflex
&	Ampersand, Epershand, or And
*	Asterisk and sometimes referred to as star.
(	Open parenthesis
)	Close parenthesis
-	Hyphen, Minus or Dash
_	Underscore
+	Plus
=	Equals
{	Open Brace, squiggly brackets, or curly bracket
}	Close Brace, squiggly brackets, or curly bracket
[	Open bracket
]	Close bracket
|	Pipe, Or, or Vertical bar
\	Backslash or Reverse Solidus
/	Forward slash, Solidus, Virgule, or Whack
:	Colon
;	Semicolon
“	Quote, Quotation mark, or Inverted commas
‘	Apostrophe or Single Quote
<	Less Than or Angle brackets
>	Greater Than or Angle brackets
,	Comma
.	Period, dot or Full Stop
?	Question Mark

Keyboards Are Not Equal

Keyboards feel different, and prospective buyers should spend time testing any laptop computer before purchasing it. Even popular laptops can have awkward cursor, Page Up/Down, Home and End key placements or reduced sizes. This can be critical and mainly affects the fast touch typist.

A desktop computer keyboard can be replaced at any time with a high-quality keyboard, and that same, premium keyboard can be plugged into a laptop, but this is not an optimum solution when traveling.

The Bat Keyboard

People with the use of only one hand can type on Info grip's Bat keyboard by pressing keys like piano chords. Some people also use the Bat to type with one hand while they move the mouse with the other

What Happened to Innovation?

In the 1990s, Samsung introduced an excellent, ergonomic laptop keyboard that offered an adjustable V shape, and IBM introduced its famous Track Write keyboard. The latter, known as the "Butterfly" keyboard, popped out of the laptop into a full-size keyboard. There has been little innovation on laptop keyboards ever since.

6.2 CONNECTIONS: DIN, USB, WIRELESS

A connector is the unique end of a plug, jack, or the edge of a card that connects into a port. When referring to cables, the connector is the end of the cable that connects into a port. For example, the end of a USB cable has a connector that allows it to connect into a USB port.

All desktop computer expansion cards have a connector that allows the card to be connected into a slot on the motherboard.

6.2.1 DIN Connector

A DIN connector encompasses several types of cables that plug into an interface to connect devices. It has an architecture that is composed of multiple pins that are within a protective circular sheath. Typically, a full-sized DIN connector has three to 14 pins with a diameter of 13.2 millimeters.

The DIN connector was initially standardized by the Deutsches Institut für Normung (DIN), the organization for the German national standards. DIN standards pertain to various DIN connectors. The term DIN connector does not refer to a specific cable but entails all connectors that meet the DIN standard.

In computer electronics, the DIN connector is referred to as a circular connector that is DIN standardized and used for digital interfaces like the musical instrument digital interface (MIDI), the IBM AT computer keyboard or mouse, and in analog video architectures. Original DIN standards for older connectors are no longer in print and have been supplanted with the corresponding international standard IEC 60130-9.

Techopedia explains DIN Connector

A DIN connector is a type of electronic cable that was widely accepted as the standard for many years and for various applications. It is comprised of a protective metal skirt that contains straight round pins. The skirt is strategically keyed to allow the plug to be inserted correctly and to prevent damage to the pins. However, keying is uniformed in all original DIN connectors and can be accidently connected to the wrong mate, which may cause damage. The introduction of the Mini-DIN prevented possible misconnections.

There are seven familiar patterns with three to eight pins with different five-pin connectors: 180°and 240° or 270°. The 180° five-pin connector was sometimes used to connect a stereo recorder to an amplifier using four of the pins for a connection and one to ground. This was sometimes called a DIN cord, DIN lead or DIN cable.

The 3/180° and 5/180° connectors were originally designed to connect analog audio equipment such as stereo tape recorders to amplifiers or preamplifiers using four pins to connect and one to ground the system. The cable has a connection on both ends with each pin matching up to the other pin.

The 5/180° connectors are normally used for various applications like:

- Control interface for antenna line devices
- Serial ports in the original Apple IIc computer
- MIDI interface for electronic musical instruments
- DIN sync interface for electronic musical instruments
- Connecting two controllers for radio controlled model aircraft
- Audio equipment such as the original HME wireless communicators and inbound/outbound audio for drive-through restaurants
- Keyboard and mouse connectors for the original IBM PC and IBM Personal Computer

6.2.2 USB

A Universal Serial Bus (**USB**) is a common interface that enables communication between devices and a host controller such as a personal computer (PC). It connects peripheral devices such as digital cameras, mice, keyboards, printers, scanners, media devices, external hard drives and flash drives. Because of its wide variety of uses, including support for electrical power, the USB has replaced a wide range of interfaces like the parallel and serial port.

Keyword

USB: It is the short for Universal Serial Bus, is a standard type of connection for many different kinds of devices.

A USB is intended to enhance plug-and-play and allow hot swapping. Plug-and-play enables the operating system (OS) to spontaneously configure and discover a new peripheral device without having to restart the computer. As well, hot swapping allows removal and replacement of a new peripheral without having to reboot.

Although there are several types of USB connectors, the majority of USB cables are one of two types, type A and type B. The USB 2.0 standard is type A; it has a flat rectangle interface that inserts into a hub or USB host which transmits data and supplies power. A keyboard or mouse are common examples of a type A USB connector. A type B USB connector is square with slanted exterior corners. It is connected to an upstream port that uses a removable cable such as a printer. The type B connector also transmits data and supplies power. Some type B connectors do not have a data connection and are used only as a power connection.

More about USB

The Universal Serial Bus standard has been extremely successful. USB ports and cables are used to connect hardware such as printers, scanners, keyboards, mice, flash drives, external hard drives, joysticks, cameras, and more to computers of all kinds, including desktops, tablets, laptops, netbooks, etc.

USB has become so common that will find the connection available on nearly any computer-like device such as video game consoles, home audio/visual equipment, and even in many automobiles.

Many portable devices, like smartphones, ebook readers, and small tablets, use USB primarily for charging. USB charging has become so common that it is now easy to find replacement electrical outlets at home improvement stores with USB ports built it, negating the need for a USB power adapter.

USB Versions

There have been three major USB standards, 3.0 being the newest:

USB 3.0: Called Super Speed USB, USB 3.0 compliant hardware can reach a maximum transmission rate of 5 Gbps (5,120 Mbps). A planned update to the USB 3.0 standard will increase the maximum data rate to 10 Gbps (10,240 Mbps), matching that of Thunderbolt, a potential replacement for USB.

USB 2.0: Called High-Speed USB, USB 2.0 compliant devices can reach a maximum transmission rate of 480 Mbps.

USB 1.1: Called Full Speed USB, USB 1.1 devices can reach a maximum transmission rate of 12 Mbps.

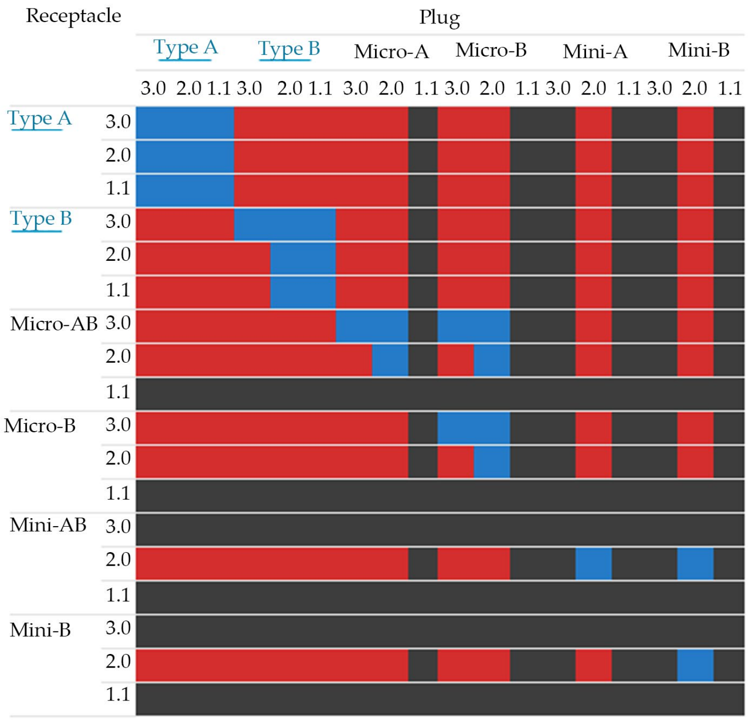
Most USB devices and cables today adhere to USB 2.0, and a growing number to USB 3.0.

Important: The parts of a USB-connected system, including the host (like a computer), the cable, and the device, can all support different USB standards so long as they are physically compatible. However, all parts must support the same standard if want it to achieve the maximum data rate possible.

USB Connectors

USB connectors come in many shapes and sizes as there are many different devices that utilize them. Every version of USB connector including standard, Mini, and Micro have two or more variations of connectors.

- USB Type A: Officially called USB Standard-A, these plugs and receptacles are rectangular in shape and are the most commonly seen USB connectors. USB 1.1 Type A, USB 2.0 Type A and USB 3.0 Type A plugs and receptacles are physically compatible.
- USB Type B: Officially called USB Standard-B, these plus and receptacles are square shaped with an extra notch on top, most noticeable on USB 3.0 Type B connectors. USB 1.1 Type B and USB 2.0 Type B plugs are physically compatible with USB 3.0 Type B receptacles but USB 3.0 Type B plugs are not compatible with USB 2.0 Type B or USB 1.1 Type B receptacles.



A USB Powered-B connector is also specified in the USB 3.0 standard. This receptacle is physically compatible with USB 1.1 and USB 2.0 Standard-B plugs, and of course USB 3.0 Standard-B and Powered-B plugs as well.

- USB Micro-A: USB 3.0 Micro-A plugs look like two different rectangular plugs fused together, one slightly longer than the other. USB 3.0 Micro-A plugs are only compatible with USB 3.0 Micro-AB receptacles.
- USB 2.0 Micro-A plugs are very small and rectangular in shape, resembling in many ways a shrunken USB Type A plug. USB Micro-A plugs are physically compatible with both USB 2.0 and USB 3.0 Micro-AB receptacles.
- USB Micro-B: USB 3.0 Micro-B plugs look almost identical to USB 3.0 Micro-A plugs in that they appear as two individual, but connected, plugs. USB 3.0 Micro-B plugs are compatible with both USB 3.0 Micro-B receptacles and USB 3.0 Micro-AB receptacles.
- USB 2.0 Micro-B plugs are very small and rectangular but the two corners on one of the long sides are beveled. USB Micro-B plugs are physically compatible with both USB 2.0 Micro-B and Micro-AB receptacles, as well as USB 3.0 Micro-B and Micro-AB receptacles.
- USB Mini-A: The USB 2.0 Mini-A plug is rectangular in shape but one side is more rounded. USB Mini-A plugs are only compatible with USB Mini-AB receptacles. There is no USB 3.0 Mini-A connector.

- USB Mini-B: The USB 2.0 Mini-B plug is rectangular in shape with a small indention on either side, almost looking like a stretched out piece of bread when looking at it head-on. USB Mini-B plugs are physically compatible with both USB 2.0 Mini-B and Mini-AB receptacles. There is no USB 3.0 Mini-B connector.

6.2.3 Wireless

Keyword

Wireless: The term "wireless" can be rather ambiguous, since it may refer to several different wireless technologies.

Wireless is a term used to describe telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or all of the communication path. Some monitoring devices, such as intrusion alarms, employ acoustic waves at frequencies above the range of human hearing; these are also sometimes classified as wireless.

The first wireless transmitters went on the air in the early 20th century using radiotelegraphy (Morse code). Later, as modulation made it possible to transmit voices and music via wireless, the medium came to be called "radio." With the advent of television, fax, data communication, and the effective use of a larger portion of the spectrum, the term "wireless" has been resurrected.

Common examples of wireless equipment in use today include:

- Cellular phones and pagers -- provide connectivity for portable and mobile applications, both personal and business

- Global Positioning System (GPS) -- allows drivers of cars and trucks, captains of boats and ships, and pilots of aircraft to ascertain their location anywhere on earth
- Cordless computer peripherals -- the cordless mouse is a common example; keyboards and printers can also be linked to a computer via wireless
- Cordless telephone sets -- these are limited-range devices, not to be confused with cell phones
- Home-entertainment-system control boxes -- the VCR control and the TV channel control are the most common examples; some hi-fi sound systems and FM broadcast receivers also use this technology
- Remote garage-door openers -- one of the oldest wireless devices in common use by consumers; usually operates at radio frequencies
- Two-way radios -- this includes Amateur and Citizens Radio Service, as well as business, marine, and military communications
- Baby monitors -- these devices are simplified radio transmitter/receiver units with limited range
- Satellite television -- allows viewers in almost any location to select from hundreds of channels
- Wireless **LANs** or local area networks -- provide flexibility and reliability for business computer users

Wireless technology is rapidly evolving, and is playing an increasing role in the lives of people throughout the world. In addition, ever-larger numbers of people are relying on the technology directly or indirectly. (It has been suggested that wireless is overused in some situations, creating a social nuisance.) More specialized and exotic examples of wireless communications and control include:

Keyword

LAN: A local area network is a group of computers and associated devices that share a common communications line or wireless link.

- General Packet Radio Service (GPRS) -- a packet-based wireless communication service that provides continuous connection to the Internet for mobile phone and computer users
- Enhanced Data GSM Environment (EDGE) -- a faster version of the Global System for Mobile (GSM) wireless service

- Universal Mobile Telecommunications System (UMTS) -- a broadband, packet-based system offering a consistent set of services to mobile computer and phone users no matter where they are located in the world
- Wireless Application Protocol (WAP) -- a set of communication protocols to standardize the way that wireless devices, such as cellular telephones and radio transceivers, can be used for Internet access
- i-Mode -- the world's first "smart phone" for Web browsing, first introduced in Japan; provides color and video over telephone sets.

Wireless can be divided into:

- Fixed wireless -- the operation of wireless devices or systems in homes and offices, and in particular, equipment connected to the Internet via specialized modems
- Mobile wireless -- the use of wireless devices or systems aboard motorized, moving vehicles; examples include the automotive cell phone and PCS (personal communications services)
- Portable wireless -- the operation of autonomous, battery-powered wireless devices or systems outside the office, home, or vehicle; examples include handheld cell phones and PCS units
- IR wireless -- the use of devices that convey data via IR (infrared) radiation; employed in certain limited-range communications and control systems

6.3 MOUSE

A mouse is a small device that a computer user pushes across a desk surface in order to point to a place on a display screen and to select one or more actions to take from that position. A mouse is a small device that a computer user pushes across a desk surface in order to point to a place on a display screen and to select one or more actions to take from that position. The mouse first became a widely used computer tool when Apple Computer made it a standard part of the Apple Macintosh. Today, the mouse is an integral part of the **graphical user interface** (GUI) of any personal computer. The mouse apparently got its

Keyword

graphical user interface is a form of user interface that allows users to interact with electronic devices through graphical icons and audio indicator such as primary notation, instead of text-based user interfaces, typed command labels or text navigation.

name by being about the same size and color as a toy mouse. A mouse consists of a metal or plastic housing or casing, a ball that sticks out of the bottom of the casing and is rolled on a flat surface, one or more buttons on the top of the casing, and a cable that connects the mouse to the computer. As the ball is moved over the surface in any direction, a sensor sends impulses to the computer that causes a mouse-responsive program to reposition a visible indicator (called a cursor) on the display screen. The positioning is relative to some variable starting place. Viewing the cursor's present position, the user readjusts the position by moving the mouse.

The most conventional kind of mouse has two buttons on top: the left one is used most frequently. In the Windows operating systems, it lets the user click once to send a "Select" indication that provides the user with feedback that a particular position has been selected for further action. The next click on a selected position or two quick clicks on it causes a particular action to take place on the selected object. For example, in Windows operating systems, it causes a program associated with that object to be started. The second button, on the right, usually provides some less-frequently needed capability. For example, when viewing a Web page, one can click on an image to get a popup menu that, among other things, lets save the image on hard disk. Some mouse has a third button for additional capabilities. Some mouse manufacturers also provide a version for left-handed people.

6.3.1 Types of Mouse

Mouse button have been making computing tasks easier for many years. Over time, mouse has already been specifically manufactured to simplify certain tasks. Optical mouse offer more fluid movement, and a lot of the wireless. Ergonomic mouse are already designed to help arthritis and CTS sufferers. Together with the various mouse available, it can search for a mouse designed for requirements. Websites including Quill and OfficeMax give a various personal computer mouse from which to choose, including:

Traditional Mouse

Traditional computer mouse button will be the most affordable, when they make use of a simple construction. They connect to personal machine utilizing the mouse port, and some mouse for Apple computers use a USB connection. Most mice include a USB connection for those who love the USB port within the mouse port.

No special application is needed, while it need to reboot after connecting in case are employing an older version of Windows. This kind of mouse does need to be periodically disassembled for cleaning. One should make use of a lint-free, static-free cloth for cleaning. It will eliminate harm to mouse preventing any bothersome lint buildup.

Optical Mouse

Optical mouse have become more commonplace. They exercise efficiently, because they lack the ball found in traditional mouse. The majority are built to be ergonomic, so we are able to make use of them very comfortably. There are especially appropriate users with cts or arthritis.

These mouse are less vulnerable to collecting dust than traditional mouse are and require less cleaning. Most optical mouse hook up to computer through the USB port. Special software usually is not necessary if one do not need advanced functions enabled for the mouse. One are able to enable any special functions that we want mouse to accomplish when using the driver CD that had the mouse.

Keyword

Optical Mouse: An optical mouse is an advanced computer pointing device that uses a light-emitting diode (LED), an optical sensor, and digital signal processing (DSP) in place of the traditional mouse ball and electromechanical transducer.

Wireless Mouse

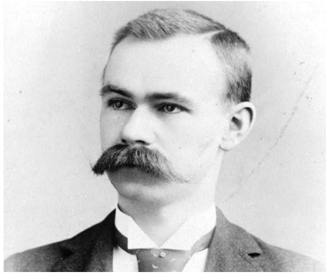
Wireless mouse provide capability of connecting without cables. That is very useful for gamers as well as others who want room to freely move their mouse. A button 'talks' to the computer with the infrared port that just attach some newer laptops consist of built-in infrared ports where we can start employing the mouse without special hardware.

These sorts of mouse include the necessary driver software. We will normally be capable to start using brand-new mouse during first minutes. Wireless mouse are optical, taking into account easier movement. Many wireless mice are purchased plus a wireless keyboard. When we have got a large enough monitor, we are able to safely sit well back through the computer and still have the capacity to apply it efficiently.

Laptop Mouse

Laptop mouse have numerous of identical features as desktop mouse. They give a more compact design that's well-suited to smaller spaces that laptops are utilized in. These mouse are ideal for laptop users unaccustomed to track pads. Additionally they are useful if track pad fails and possess zero chance to change it instantly. Laptop mouse use a retractable cord having a USB connection or may include wireless connection.

ROLE MODEL



HERMAN HOLLERITH WAS THE INVENTOR OF THE PUNCHED CARD TABULATING MACHINE

Herman Hollerith (1860-1929) was the inventor of the punched card tabulating machine-the precursor of the modern computer-and one of the founders of modern information processing. His machine was used to gather information for the 1890 census more efficiently. Hollerith's company later became part of International Business Machines (IBM).

Herman Hollerith was born to German immigrants, George and Franciska (Brunn) Hollerith, on February 29, 1860 in Buffalo, New York. He began his university education at the City College of New York at the age of 15, and graduated from the Columbia School of Mines with distinction in 1879. While at Columbia, Hollerith took the standard course of study which required both classes and practical work. As an engineering student, he took chemistry, physics, and geometry, as well as courses in surveying and graphics, and surveying and assaying. Hollerith was also required to visit local industries, such as metallurgical and machine shops, in order to understand how they functioned.

Shortly after graduation, Hollerith got a job at the U.S. Census Bureau as an assistant to his former teacher, William Petit Trowbridge. He worked as a statistician, compiling information on manufacturers. His article, "Report on the Statistics of Steam and Water-Power Used in the Manufacture of Iron and Steel," was published in 1888 in the Census Bureau's *Report on Power and Machinery Employed in Manufacture.* His work revealed the problems of dealing with large amounts of data by hand. The 1880 census took seven and a half years to complete. Because of the large numbers of people immigrating to the U.S., the 1890 and 1900 censuses were expected to take much longer.

At the Census Bureau, Hollerith met Kate Sherman Billings, daughter of Dr. John Shaw Billings, head of the Department of Vital Statistics. In addition to his work at the Bureau, Billings designed seven medical institutions and the New York Public Library, was chair of the Carnegie Institution, member of the

National Board of Health, and oversaw publication of the *Index Medicus,* which contained abstracts of medical publications. Because Billings liked to help talented young men, and because Hollerith was dating his daughter, Billings took an interest in him.

It was Billings who was thought to have provided Hollerith with the inspiration for the punched card tabulating machine. Hollerith acknowledged near the end of his life the help that Billings had given him. While Billings denied providing much assistance, it is clear that he relied heavily on Billing's design concept. Hollerith thought he could design the machine, and later offered to include Billings in the project.

In 1882, Hollerith became an instructor of mechanical engineering at the Massachusetts Institute of Technology (MIT). Because he disliked working with students, he left to go to St. Louis, Missouri, where he experimented with and designed an electrically activated brake system for railroads. The railroads, however, chose a steam-actuated brake system which had been designed by Westinghouse. In 1884, Hollerith got a job with the U.S. Patent Office in Washington, D.C., where he remained until 1890.

Invented the Tabulating Machine

Hollerith continued to experiment with the elements for a punched card tabulating machine. Billings had recommended that he study a Jacquard loom, a mechanical loom or weaving machine, for inspiration. Jacquard had realized that weaving required a number of repetitive tasks which could be automated. "He conceived a system that relied on stiff pasteboard cards with various patterns of punched holes. At each throw of the shuttle, a card was placed in the path of the rods. The pattern of holes in the card determined which rods could pass through and thus acted as a program for the loom. This control system allowed for flexibility and various levels of complexity in the patterns," noted Mark Russo, in *The World's First Statistical Engineer.*

From the Jacquard loom, Hollerith deduced the pattern for his first attempt at constructing his tabulating machine. He used a single, continuous paper feed with holes punched in it, something like a player piano. The position of the hole on a line of the paper determined what it stood for. For example, a hole in one position indicated a male, in another a female; a hole in another position indicated that the person was born in the U.S., one in another, the person was a foreigner. As the roll of paper was fed through the tabulating machine, the holes would pass over a drum, completing an electrical circuit for each hole. Counters connected to the machine registered each electrical current caused by a hole as a hit for that statistic. Because it used electricity, Hollerith's tabulating machine anticipated the advent of computers. Also, the hole punching system is analogous to the binary system of zeros and ones, which is found in the digital data storage of computers. The continuous strip which Hollerith initially used was similar to the tapes used in early computers.

The problems with Hollerith's continuous paper strip were that it was easy to tear, it was difficult to find a specific piece of information on the strip, and it was almost impossible to re-sort information. For these reasons, Hollerith decided to use a card similar to the Jacquard cards used on the looms. The cards, which came to be called Hollerith cards, were small stiff-paper cards, the size of one dollar bills. The advantage of the cards was their relatively small size, and the fact that they could be sorted or re-sorted, and corrected. The drum was replaced by a press which sandwiched the cards. Pins over the holes would pass through the cards to be submerged in mercury, which created electrical circuits that yielded hits on counters.

In 1884, Hollerith was awarded his first patent and a contract to test the merits of his new machine. In spite of some problems, the test of mortality statistics at the Baltimore Office of Registration was successful enough that the machine was subsequently used in New Jersey and New York City for similar purposes. In 1885, Hollerith's machine was first used by the U.S. Navy. This military use gave Hollerith added prestige, increased sales, and the financial resources needed to make improvements.

The 1880 census was still not completed by 1885. Hollerith felt that his machine would speed the counting of the 1890 census. The Census Bureau was worried that they might have to count two censuses at the same time, because of the length of time it took to count them. The Bureau held a competition which proved Hollerith's machine much faster than any of its competitors. By the time of the 1890 census, Hollerith had made more improvements. He increased the categories which the machine could count, and adding a mechanical feeding device and a sorting box with a number of compartments. With Hollerith's machine, the counting for the 1890 census was completed in six weeks. The census was finished in two and a half years rather than the seven and a half years needed for the previous one. Hollerith had saved the U.S. five million dollars in expenses.

On September 15, 1890, Hollerith married Lucia Beverly Talcott. The couple subsequently had six children: Lucia, Nannie, Virginia, Herman, Richard, and Charles. Also in 1890, he was awarded the Elliott Cresson medal from the Franklin Institute of Philadelphia for the outstanding invention of the year.

Expanded Uses of Machine

By 1891, Hollerith's machines were being used to gather census information in Canada, Austria, and Norway. Between 1890 and 1900, he expanded the commercial uses of his machines to include railroad freight statistics and agricultural data. In 1896, Hollerith started the Tabulating Machine Company, to make his machines and sell the cards needed for them. Although business was good, Hollerith was suffering from emotional exhaustion. His employees never knew what he was going to do next. It was rumoured that he had extra strong doors installed in his home so that they would not fly off their hinges during his fits. His emotional state led to a falling out with the director of the census, which now handled much more statistical data for the government. After this incident, Hollerith devoted himself entirely to commercial work.

Never a man to leave things as they were, Hollerith immediately found new markets for his machines in the business world. Within 18 days after his machines were removed from the Census Bureau, he had placed them at the shops of the Atchison, Topeka, & Santa Fe Railroad and at the Denver Gas & Electric Co. Between 1905 and 1909, he substantially developed his business as he won over a number of large accounts and introduced an updated version of his machines.

In 1911, his company merged with two other companies, the Computing Scale Company of America and the International Time Recording Company, to become the Computing-Tabulating-Recording Company. Hollerith stayed at the merged company as a consulting engineer until he retired in 1921. In 1924, under the leadership of Thomas Watson, Sr., the merged company changed its name to International Business Machines (IBM). The machine that Hollerith developed was the initial reason for IBM's success. In his last years, Hollerith suffered from heart disease. He died at home in Washington, D.C. on November 17, 1929.

SUMMARY

- Input device enables the user to send data, information, or control signals to a computer. The Central Processing Unit (CPU) of a computer receives the input and processes it to produce the output.
- An input device is a piece of equipment used to provide data and control signals to an information processing system such as a computer or information appliance.
- Traditional keyboards use spring-based buttons, though newer variations employ. There also happens to be another keyboard that is like an input device for musical instrument which helps to produce sound.
- Keyboard is basically a board of keys. Along with the mouse, the keyboard is one of the primary input devices used with a computer. The keyboard's design comes from the original typewriter keyboards, which arranged letters and numbers in a way that prevented the type-bars from getting jammed when typing quickly.
- The computer keyboard uses the same key arrangement as the mechanical and electronic typewriter keyboards that preceded the computer.
- A connector is the unique end of a plug, jack, or the edge of a card that connects into a port. When referring to cables, the connector is the end of the cable that connects into a port.
- A DIN connector encompasses several types of cables that plug into an interface to connect devices. It has an architecture that is composed of multiple pins that are within a protective circular sheath.
- A Universal Serial Bus (USB) is a common interface that enables communication between devices and a host controller such as a personal computer (PC).
- Wireless is a term used to describe telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or all of the communication path.

KNOWLEDGE CHECK

1. **The I/O devices are sometimes called the peripheral devices because they surround the CPU and memory of the computer system.**
   a. True
   b. False
2. **What does GUI stand for?**
   a. Graphical User Instruction
   b. Ground User Interface
   c. General User Instruction
   d. Graphical User Interface
3. **Which of the following is not a point-and-draw device?**
   a. Keypad
   b. Trackball
   c. Touch screen
   d. Mouse
4. **Trackball is**
   a. Two-dimensional positioning device
   b. Three- dimensional positioning device
   c. Pointing device
   d. None of these
5. **Space ball provide________ degree of freedom.**
   a. 10 degree
   b. 6 degree
   c. 8 degree
   d. 12 degree
6. **The most commonly used input device is**
   a. Mouse
   b. Keyboard
   c. Scanner
   d. Printer
7. **Which keys allows user to enter frequently used operations in a single key stroke?**
   a. Function keys
   b. Cursor control keys

c. Trackball
d. Control keys

8. ________ are used to measure dial rotations.

a. Potentiometers
b. Volta meter
c. Parameter
d. Only a

9. The device which is used to position the screen cursor is

a. Mouse
b. Joystick
c. Data glove
d. Both a and c

10. _________ is used for detecting mouse motion.

a. Optical sensor
b. Rollers on the bottom of mouse
c. Both a and b
d. Sensor

REVIEW QUESTIONS

1. What do you mean by the input device?
2. Discuss about the keyboard.
3. Define the USB.
4. What do you mean by wireless?
5. Define the bat keyboard.
6. Explain the din connector.
7. Write short note on:
   - Traditional Mouse
   - Optical Mouse

Check Your Result

1. (a) 2. (d) 3. (a) 4. (a) 5. (b) 6. (b)

7. (a) 8. (d) 9. (a) 10. (c)

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CHAPTER 7

PRINTERS

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define the printers
2. Understand installing a printer on windows pc
3. Performing basic printer maintenance
4. Describe the recognizing and fixing basic printing problems

"Creating life at the speed of light is part of a new industrial revolution. Manufacturing will shift from centralized factories to a distributed, domestic manufacturing future, thanks to the rise of 3D printer technology."

— ***Craig Venter***

INTRODUCTION

A printer is an external hardware output device that takes the electronic data stored on a computer or other device and generates a hard copy. For example, if you created a report on your computer, you could print several copies to hand out at a staff meeting. Printers are one of the most popular computer peripherals and are commonly used to print text and photos.

There are a few different ways a printer can connect to and communicate with a computer (referred to as interfaces). Today, the most common connection types are by USB cable (wired) or via Wi-Fi (wireless). Below is a full list of cables and interfaces used to connect a computer to a printer?

- Cat 5
- Firewire
- MPP-1150
- Parallel port
- SCSI
- Serial port
- USB
- Wi-Fi

A printer is a device that accepts text and graphic output from a computer and transfers the information to paper, usually to standard size sheets of paper. Printers are sometimes sold with computers, but more frequently are purchased separately. Printers vary in size, speed, sophistication, and cost. In general, more expensive printers are used for higher-resolution color printing. The most commonly used printer can vary depending on the environment of where it's used. For home and family users, inkjet printers are the most commonly used because of their initial price. For office environments, laser printers are the most common.

7.1 OVERVIEW OF PRINTERS

External device that communicates with another digital device to print what a user sees on a screen. Printers use small pixels to transfer an image from the system to another surface. Ink jet and laser printers are the most commonly used varieties of this device, and are most commonly hooked up to a personal computer. Some printers only print in black and white, but most include a color option as well. Inkjet printers are commonly used by consumers, while laser printers are a typical choice for businesses. Dot matrix printers, which have become increasingly rare, are still used for basic text printing.

7.1.1 Current Printer Technologies

3D printing is an additive technology in which objects are built up in a great many very thin layers. The first commercial 3D printer was based on a technique called stereo lithography. This was invented by Charles Hull in 1984. The creation of a 3-D object through an additive printing process. 3-D printing allows the small scale manufacturing of objects out of a variety of materials, including plastics and powders, through a variety of processes. Printing an object using a 3-D printer is different than printing a word document. The 3-D printer follows an additive process, meaning that the print nozzle lays down successive layers of a material, such as plastic or powder. The layers are built up until the object is complete, though further finishing may be required in order to add details or remove imperfections.

The amount of time it takes to print an object depends on its size and complexity. Objects constructed using thin layers will likely take longer to produce, though may provide greater detail than objects constructed of thicker layers. Layer thickness and the size of material particles are typically measured in micrometers. As a technology, 3-D printing has been lauded for its ability to give small scale manufacturers the ability to create prototypes of new products quickly and cheaply, especially when compared to older manufacturing processes. Because it follows an additive process, 3-D printing could be used to create complicated objects, such as those with holes or curves. While objects can be highly customized, the slow speed at which 3-D printed objects are created makes it difficult to create objects through mass production.

DID YOU KNOW?

The general concept of and procedure to be used in 3D-printing was first described by Murray Leinster in his 1945 short story Things Pass By “But this constructor is both efficient and flexible.

7.1.2 Printer Languages

Printer languages are commands from the computer to the printer to tell the printer how to format the document being printed. These commands manage font size, graphics, compression of data sent to the printer, color, etc. The two most popular printer languages are Postscript and Printer Control Language.

Postscript is a printer language that uses English phrases and programmatic constructions to describe the appearance of a printed page to the printer. This printer language was developed by Adobe in 1985. It introduced new features such as outline font s and vector graphics. Printers now come from the factory with or can be loaded with Postscript support. Postscript is not restricted to printers. It can be used with any device that creates an image using dots such as screen displays, slide recorders, and image setters.

PCL (Printer Command Language) is an escape code language used to send commands to the printer for printing documents. Escape code language is so-called because the escape key begins the command sequence followed by a series of code numbers.

Hewlett Packard originally devised PCL for dot matrix and inkjet printers. Since its introduction, it has become an industry standard. Other manufacturers who sell HP clones have copied it. Some of these clones are very good, but there are small differences in the way they print a page compared to real HP printers. In 1984, the original HP LaserJet printer was introduced using PCL. PCL helped change the appearance of low-cost printer documents from poor to exceptional quality.

Keyword

Printer Command Language: It is a page description language (PDL) developed by Hewlett-Packard as a printer protocol and has become a de facto industry standard.

7.1.3 Fonts

A **font** is a set of characters of a specific style and size within an overall typeface design. Printers use resident fonts and soft fonts to print documents. Resident fonts are built into the hardware of a printer.

They are also called internal fonts or built-in fonts. All printers come with one or more resident fonts. Additional fonts can be added by inserting a font cartridge into the printer or installing soft fonts to the hard drive. Resident fonts cannot be erased unlike soft fonts. Soft fonts are installed onto the hard drive and then sent to the computer's memory when a document is printed that uses the particular soft font. Soft fonts can be purchased in stores or downloaded from the Internet.

There are two types of fonts used by the printer and screen display, bitmap fonts and outline fonts. Bitmap fonts are digital representations of fonts that are not scalable. This means they have a set size or a limited set of sizes. *For example*, if a document using a bitmap font sized to 24 point is sent to the printer and there is not a bitmap font of that size, the computer will try to guess the right size. This results in the text looking stretched-out or squashed.

Jagged edges are also a problem with bitmap fonts. Outline fonts are mathematical descriptions of the font that are sent to the printer. The printer then rasterizes or converts them to the dots that are printed on the paper.

Because they are mathematical, they are scalable. This means the size of the font can be changed without losing the sharpness or resolution of the printed text. TrueType and Type 1 fonts are outline fonts. Outline fonts are used with Postscript and PCL printer languages.

7.1.4 Types of Printer

In the market many type of printers are available. Some printer description given as following:

Dot Matrix Printer

Type of computer printer that uses tiny hammers in its print head to strike pins over an inked ribbon to form characters or images on paper, and is used mainly for multipart forms. For general printing, dot matrix printers have largely been replaced by cheaper, quieter, and faster non-impact printers such as ink jets and lasers which also produce output of far better quality

A dot matrix is a 2D matrix of dots that can represent images, symbols, or characters. They are used for electronic displays, such as computer monitors and led screens, as well as printed output.

In a dot matrix display, the images are estimated using a discrete set of dots instead of lines and shapes. Therefore, the more dots that are used, the more clear and accurate the image representation will be.

A 16x16 dot matrix can represent the letter "S" more accurately than an 8x8 matrix.

If enough dots are used, the image will appear as a contiguous display rather than a group of dots. This is because the human eye blends the dots together to create a coherent image.

For example, newspaper print is made up of dot matrixes, but it is hard to notice unless you look very closely at the paper.

Bitmap images on a computer screen are also dot matrixes, since they are made up of a rectangular grid of pixels. If you look closely enough at your monitor, you may even be able to see the dots that make up the image. But be nice to your eyes and do not stare too long.

While "dot matrix" has a broad definition, it can also be used to describe a specific type of printer. Dot matrix printers, or "**impact printers**," were introduced in the 1970s. These printers typically use the kind of paper with small holes on each side that are used to feed the paper through the printer. They are called dot matrix printers because they use a matrix of dots to print each character. While they do not have a very high resolution, dot matrix printers are effective ways of printing basic text documents. Therefore, while most businesses now use inkjet or laser printers, some organizations still find dot matrix printers to be an efficient printing solution.

Keyword

Impact Printers: It creates an image by using some mechanism to physically press an inked ribbon against the page, causing the ink to be deposited on the page in the shape desired.

This printer draws one character at a time from a dot matrix, usually consisting of either 9 or 24 pins, then striking a number of metal pins against an inked ribbon, transferring the image to a sheet of tractor-feed paper. A dot matrix printer can print at high speed for many hours at a time with little to no human intervention. The speed of a dot matrix printer is measured in cps, or characters per second. Line width is generally 80 characters, or columns, with some dot matrix printers being capable of 132-character lines.

Inkjet Printer

An inkjet printer is a computer peripheral that produces hard copy by spraying ink onto paper. A typical inkjet printer can produce copy with a resolution of at least 300 dots per inch. Some inkjet printers can make full color hard copies at 600 dpi or more. Many models include other devices such as a scanner, photocopier, and dedicated fax machine along with the printer in a single box.

In the inkjet printing mechanism, the print head has several tiny nozzles, also called jets. As the paper moves past the print head, the nozzles spray ink onto it, forming the characters and images. An inkjet printer can produce from 100 to several hundred pages, depending on the nature of the hard copy, before the ink cartridges must be replaced. There is usually one black ink cartridge and one so-called color cartridge containing ink in primary pigments (cyan, magenta, and yellow). Some inkjet printers use a single cartridge with cyan, magenta, yellow, and black ink. A few models require separate cartridges for each primary pigment, along with a black ink cartridge.

REMEMBER

The print head must be resistant to the repeated heating and cooling cycles performed rapidly. The cooling process of the ink causes a delay, which reduces to a certain extent the printing speed.

The principal advantage of inkjet printers is the fact that most of them are inexpensive. Inkjet printers are often given away at computer superstores along with the purchase of a personal computer or substantial peripheral. Even the cheapest inkjet printers are satisfactory for most of the needs of personal computer users. High-end inkjet printers can render digital images on special paper, with quality rivaling that of professionally produced glossy or matte photographs. Another advantage of inkjet printers is their light weight and modest desktop footprint. Many models are easy to transport, and are preferred by traveling salespeople for this reason alone.

The copy rom an inkjet printer needs a little time to dry. Adequate drying time is especially important if the hard copy contains large regions of solid black or color. Inkjet printers also require non-porous paper. In bond paper containing cotton or other fibers, the ink may bleed along the fibers. Paper designed especially for inkjet printers is heavier than the paper used with laser printer s or photocopiers, has higher brilliance, and is somewhat more expensive. Another limitation is the fact that most inkjet printers are slow and they are not designed for high-volume print jobs. While the initial cash outlay for an inkjet printer may be modest (or zero), this type of printer is expensive to operate over time compared with a laser printer.

Keyword

Photocopier: It is a machine that makes paper copies of documents and other visual images quickly and cheaply.

Laser Printer

A laser printer is a popular type of personal computer printer that uses a non-impact (keys do not strike the paper), **photocopier** technology. When a document is sent to the printer, a laser beam "draws" the document on a selenium-coated drum using electrical charges. After the drum is charged, it is rolled in toner, a dry powder type of ink. The toner adheres to the charged image on the drum. The toner is transferred onto a piece of paper and fused to the paper with heat and pressure. After the document is printed, the electrical charge is removed from the drum and the excess toner is collected. Most laser printers print only in monochrome. A color laser printer is up to 10 times more expensive than a monochrome laser printer.

IBM introduced the first laser printer in 1975 for use with its mainframe computers. In 1984, Hewlett-Packard revolutionized laser-printing technology with its first LaserJet, a compact, fast, and reliable printer that personal computer users could afford. Since then, laser printers have decreased further in price and increased in quality. Hewlett Packard continues to be the leading manufacturer with competitors including Lexmark, Okidata, and Xerox.

The laser printer is different from an inkjet printer in a number of ways. The toner or ink in a laser printer is dry. In an inkjet, it is wet. Over time, an inkjet printer is about ten times more expensive to operate than a laser printer because ink needs replenishing more frequently. The printed paper from an inkjet printer will smear if wet, but a laser-printed document will not. Both types of printer operate quietly and allow fonts to be added by using font cartridges or installing soft fonts.

How to Use a Printer

For using the printer follow the instruction are as following:

If you are connected with the internet and want to print something from there open the page you want to print. All you have to do is go up to file, then down to page set up. This will give you more printing options to choose from. When you are done setting up the page you can verify you have the right printer hooked up by clicking on "Printer" at the bottom. Once everything looks good click on "OK" and now your page should print out.

If you want to print the .doc file open up a .doc file where your page is that you need to print. When you are ready to print go up to "File" and "Print Setup". Again you can choose how you want your page to look, and check and make sure the right printer is installed. If your page is set up the way you like it you can just click on the printer icon on the tool bar or go to "File" then "Print."

7.2 INSTALLING A PRINTER ON WINDOWS PC

There are several ways to connect a printer to computer. Which option you choose depends on the device itself, and whether you are at home or at the office.

Local Printers

The most common way to install a printer is to connect it directly to your computer. This is known as a local printer.

If your printer is a **universal serial bus** (USB) model, Windows should automatically detect it and begin installation when you plug it in.

If you are installing a wireless printer that connects to your computer over a wireless network (Wi-Fi), you can use the Add a device wizard to install the printer.

To install the local printers follows these steps given as:

- Open Devices and Printers by clicking the start button and then, on the Start menu, clicking devices and printers.
- Click Add a printer.
- In the Add Printer wizard, click Add a local printer.
- On the Choose a printer port page, make sure that the Use an existing port button and the recommended printer port are selected, and then click Next.
- On the Install the printer driver page, select the printer manufacturer and model, and then click Next.
  - If your printer is not listed, click Windows Update, and then wait while Windows checks for additional drivers.
  - If none are available and you have the installation CD, click Have Disk, and then browse to the folder where the printer driver is located. (For additional help, consult the printer manual.)
- Complete the additional steps in the wizard, and then click Finish.

Keyword

Universal Serial Bus: It was designed to standardize the connection of computer peripherals to personal computers, both to communicate and to supply electric power.

Network Printers

In the workplace, many printers are network printers. These connect directly to a network as stand-alone devices. Inexpensive network printers are also made for the home.

To install the network, wireless, and Bluetooth printers follows these steps given as:

If you are trying to add a network printer at the office, you will usually need the name of the printer. If you cannot find it, contact your network administrator.

- Open devices and printers by clicking the start button, and then, on the Start menu, clicking devices and printers.
- Click Add a printer.
- In the Add Printer wizard, click Add a network, wireless or Bluetooth printer.
- In the list of available printers, select the one you want to use, and then click Next.
- If prompted, install the printer driver on your computer by clicking Install driver. Administrator permission required if you are prompted for an administrator password or confirmation, type the password or provide confirmation.
- Complete the additional steps in the wizard, and then click Finish.

7.3 PERFORMING BASIC PRINTER MAINTENANCE

Here are some maintenance tips that can help you save money and extend the life of your printer and printing supplies:

- Unplug the printer before doing any maintenance on your printer.
- Shake the toner/ink. Even when your printer shows the message 'replace toner' you can get quite a few more pages printed. Be careful though to shake it gently and place an old, used paper underneath to catch any toner that might spill out.

REMEMBER

The drum must be cleaned after printing each color, and the alignment of the paper must be rigorously maintained for all four passes.

- Print a blank page. This will pick up lint, dust and stray toner when running a clean page through your printer.
- Cover your printer up and switch off when not in use. This will ensure it will not collect dust etc. and be kept nice and clean. Printers do not switch themselves off automatically, which in turn could shorten its life span.
- Clean your printer regularly on the outside and inside. Only clean the outside with a damp, lint-free cloth. Clean the inside gears and rollers along the paper path.

Keep the print heads clean

It is important you keep the printer heads clean. This stops ink clogging the nozzles of the printer, and reduces ink smudge on the paper. This is important for HP and Lexmark printers, as they do not always do the best automatic clean in my experience.

To clean the print heads, remove the cartridge, and gently clean the print heads with a soft cotton cloth dipped in a little water. We would not recommend using tissue or alcohol. We have personally damaged a few printers doing this. Be warned!

Make sure the print heads are dry and then replace the cartridge. By doing this you will expand your printer life and the quality of the printouts.

Prevent the Printer from Drying up ink by using it

We remember taking support calls around a year ago. People would say we have not used the printer for over a year, and the quality is not what we expected.

If you use your printer regular this will prevent ink drying up and keep the printer and ink in good condition. Use both Color and black and white prints weekly to stop the nozzles on your printer getting clogged up, or the ink to simply dry up.

Be Careful with Printer Jams

Do not ram the paper out if you have a paper jam. This can damage the printer, which we have seen done many times. Look at guides on the manufactures site, if you do not have time to do that, remember that you want to get the paper out smoothly. Most HP Printers have a hatch attached at the back that can be removed. You will then have access to the paper wheels, and you should be able to see the paper that is jammed in there. Remove the paper this way, and it is unlikely that you will damage the printer.

Power down Correctly

Turn your printer off when not in use. This can prevent drying of ink and also help keep the printer functioning at high quality. Remember to use the printers power button, and then remove at the plug if need be. Do not power off if you are in the middle of something. These will just cause problems for you.

Clean your Printer but do not overdo it

IF you perform print ink clean by software or your printer's hardware, do it once and not over and over. Doing this over and over can cause more damage than good. Clean your printer's encoder strip monthly to stop quality issues at a later date. Remember if you have low ink to replace immediately. This prevents ink being left in the printer heads and nozzles, and will generally give your printer more life.

7.3.1 Basic Laser Printer Care and Maintenance

Many users inherit their printers without being trained on their proper use and care. This is a quick overview of some Laser Basics

Before installing a new cartridge

- Ensure the cartridge and printer models are compatible.
- Always allow cartridges to acclimate to room temperature before use.
- Your printer should always be plugged into a surge protector and never an extension cord.
- Inspect the inside cavity of the printer and remove all visible paper dust and toner residue.
- Your printer should not be positioned in direct sunlight, directly under an AC/heat vent, or placed directly on a metal cabinet.
- To assure proper cooling and prevent fires, make sure the side vents of your printer are kept free and clear.
- Clean and inspect more frequently if your printer is heavily used, printing perforated paper or is in a dusty environment.

Cleaning the outside of the printer:

- Do not use ammonia-based cleaners on or around the printer.
- Avoid touching the transfer roller (the black, rubber roller located underneath the print cartridge) as skin oils on the roller can cause print-quality problems.

- Wipe the outside of the printer with a slightly-water-dampened cloth.

Cleaning the inside of the printer:

- If toner gets on clothing, wipe it off with a dry cloth and wash clothing in cold water (hot water sets toner into fabric).
- Turn off the printer power and unplug the power cord.
- Open the top cover and remove the print cartridge.
- Avoid reaching too far into the printer (the adjacent fusing area might be hot).
- To prevent damage to the print cartridge, do not expose it to light for more than a few minutes (for this reason, cleaning the inside of the printer is best performed when installing a new cartridge).
- Wipe any dust or dirt off the paper feed guides with a dry, lint-free cloth.
- Using the green handle, lift the paper-access plate and wipe off any residue with a dry, lint-free cloth.

Cleaning the fuser

Run the printer-cleaning page to keep the fuser free of toner and paper particles that can sometimes accumulate. Accumulation of toner and particles can cause specks to appear on the front or backside of print jobs.

To ensure optimum print quality, HP recommends using the cleaning page every time the print cartridge is replaced, or on an automatic interval that is set up. If an optional duplexer is installed, the cleaning pages must be run manually.

The cleaning procedure takes about 2.5 minutes to complete. A message, either "Creating cleaning page" or "Cleaning" appears on the printer control panel display while the cleaning is taking place.

7.3.2 Basic Cleaning and Ink Jet Printer Maintenance

The following maintenance is only for ink-jet printers. Laser printers should never be opened or disassembled except by a professional technician.

Perform head-cleaning and alignment

The printer comes with programs that automatically do this, and the printer prompts us for this after any ink cartridge replacement. If we are noticing lines are blurs in the print job this should be the first thing you do. Simply access your printer and command it to perform the task. This takes ink and paper–usually one or two pages worth.

Print with the Printer

Yes, it may seem silly, but if you do not frequently use your ink-jet printer it is something to keep in mind. Ink cartridge heads will dry and clog if they are not used weekly. If you do not have something you really want to print just have the printer shoot out a simple color picture. A small color picture pulled off the internet will use less ink than a full head-cleaning and will help keep your heads from clogging.

Dust and Remove Clutter

Keep the space around your printer clean and open. Dust and other small particles can easily get into the printer and clog or damage the heads. Do not have food or any type of liquid around the printer. Routinely dust and clean the outside surfaces of your printer with rubbing alcohol. Especially clean the feed trays where the paper sits.

Manual Deep Cleaning

Sometimes the basic programs used to clean your print-heads are not enough. In this case it is time to get down and dirty to physically clean the inside of your printer. Do not get scared now. It is not as bad as it sounds.

7.4 RECOGNIZING AND FIXING BASIC PRINTING PROBLEMS

First, make sure that the printer is on. When a printer is on it should have some light or LED (usually green) indicating it is receiving power and is on.

If you do not have any indicator light make sure the printer is connected to a working power outlet by verifying each end of the power cable. Next, press the printer power button.

Cables not Connected Properly

Your printer should have two cables connected to it. The power cable and the data cable, the power cable should have already been verified as being connected if your printer has a power indicator light. Make sure the data cable (parallel cable or USB cable) is also connected from the printer to the computer.

Printer Error (Orange or Blinking Light)

After your printer has completed its initial startup you should have a solid green light. If the light indicator is blinking or orange often this is an indication of a printer error. *For example*, this could indicate a paper jam, issue with the ink or toner cartridge, or other serious error. Because there is no standard to what a blinking light or orange light means if you are getting either of these we suggest referring to the printer documentation for troubleshooting steps or methods of determining what the status indicator is reporting.

No Paper or Paper Jam

Without paper your printer will not be able to print. Make sure you have paper in the paper loaded into the printer paper cartridge or tray. Next, verify that no printer paper is jammed or partially fed into the printer. If you have one or more pieces of paper stuck in the printer these need to be manually removed before the printer will print again.

Printer self-Tests

Most printers have a way of printing a test page. This page allows you to determine if the printer is physically working or not. This test is usually accomplished by holding down a series of keys. If you are not sure if your printer has this feature or how to perform it refers to your manual or visits your printer manufacturer's website.

In addition to testing the printer using the printer self-test Microsoft Windows users can also perform software self-test to determine if their computer can see the printer and it is able to print.

Printing is too slow

Rev up printer performance--and save ink in the process--by reducing print quality for everyday output. While printer settings vary by model, here's how to switch to draft-printing mode in most Windows apps. Select Print and Properties, and then look for a setting that reduces print quality. With the HP Photo smart 8450, for instance, change the default print quality setting from Normal to Fast Draft (click screen-shot at right). Other speedup suggestions: Print pages from websites without graphics, and add RAM to your printer, if possible.

Ink and/or Toner Costs too Much

PC World has written a lot about the printing industry's sneaky practices over the years. To wit: They snare you with dirt-cheap printers sold at or below cost, and then stick it to you later with ultra-pricey consumables.

Based on our tests, we cannot recommend third party vendors' remanufactured or refilled ink cartridges, which may not give you your money's worth. One cost-saving solution is to buy higher-capacity cartridges. If you print a lot, try an ink cartridge with a 250-plus page yield, or a toner cartridge with a 2,000-plus page yield.

Windows is Sending Print Jobs to the Wrong Printer

For some mysterious reason, Windows may select a new default printer--the one it automatically sends print jobs to. To fix this glitch in Windows 7, click Start (the Windows icon in the lower-left corner of the screen) and select Devices and Printers. Under Printers and Faxes, right-click the printer you want to make the default, and select set as default printer.

7.4.1 Inkjet Printer Problems

Getting the best prints from your inkjet printer can be tricky. Most printers will warn you when ink levels are low, but other problems are tougher to pinpoint. Whether your prints suffer from pixilation or peddling, learn how to recognize and correct the most-common print problems.

Since mechanical details vary from printer to printer, you should consult your printer's manual for specific information about solving print-head problems with your model.

Prints are lighter than Expected; Prints Contain White Spots or Horizontal Lines

These signs point to a clogged print head—especially if you have not used your printer for some time. Clean the head by running the printer's utility program. If you cannot find it, try accessing it from your Print & Fax system preference. Select your printer from the list, and click on Options & Supplies. In the resulting window, click on Utility. You may need to clean the head several times for best results. Be sure to print a test sheet between cleanings to avoid damaging the nozzles.

Should the cleaning routine not work, try leaving your printer turned off overnight. The next day, run the cleaning process again. The dried ink will soften, making it easier for the printer to clean.

If you have a chronic problem with clogged heads, make a habit of turning your printer off at night. (Turn it off at the printer, not at the power strip.) In some models, doing so will engage a capping mechanism that protects the nozzles.

Most printer utilities will let you print a test sheet that uses all the printer's ink cartridges. If you have not printed a color image in a while, print a test sheet before printing a large file—it wastes less ink than a bad print.

Vertical Lines are jagged

Most inkjet printers come with a printer utility that lets you perform basic troubleshooting tasks such as cleaning the print heads. This is usually a sign that the print head is out of alignment. There's not much you can do to avoid this problem all print heads become misaligned over time. Your printer utility should include an option for correcting the problem.

Colors are Missing; Prints Lack Shadows and Contrast

Colors may begin to print inconsistently even before your printer instructs you to replace a cartridge. Try replacing them; this may improve color quality.

If there's enough ink but your print seems to be missing a particular color, you probably have a clogged nozzle, so you will need to clean your print head. If your print lacks shadows and contrast, the black ink cartridge is the likely culprit. Color quality can also suffer if ink cartridges have been in the printer for more than six months. Try swapping in a new cartridge. If your image looks psychedelic, make sure you have not loaded an ink cartridge in the wrong color slot most modern printers will warn you if this happens.

Pictures are Grainy

If you have already cleaned and aligned your print head and your images still look as though they have old- fashioned film grain rather than smooth gradations, try switching to a higher-quality print setting. If that does not solve the problem, the culprit may be low-quality paper. Try printing on a sheet of the manufacturer's recommended paper and see if the image quality improves. You will usually get the best results and encounter fewer problems if you use high-quality paper and your printer manufacturer's inks.

ROLE MODEL

GARY STARKWEATHER

In 1938 the American physicist and inventor Chester Carlson (1906-1968) (see the nearby image) invented a dry printing process, called later Xerography (the word comes from the Greek for dry writing), the foundation technology for copiers and laser printers to come. Carlson applied for patent in 1939 and in 1942 the patent was granted (US patent 2297691). After several years unsuccessful attempts to catch the interest of companies to his invention, in 1947 Carlson succeeded to negotiate commercial rights to his invention to Haloid Company (later renamed Xerox). This was the deal of the life not only for Carlson, but also for the completely unknown company Haloid, which will become one of biggest companies in the world due to this invention.

In 1967 a young researcher in Xerox's Webster Research Center in Rochester, Gary K. Starkweather (B.S. in Physics from Michigan State University in 1960, and a M.S. in Optics from the University of Rochester in 1966) was sitting in his lab looking at all of these big mainframes when he started thinking: What if, instead of copying someone else's original, which is what a facsimile does, we used a computer to generate the original? And so the idea of the laser printer was born.

In this times the lasers were rather expensive devices, but convinced that the cost of lasers would drop over time and that there was a market for laser printing technology, Starkweather stuck to his guns. His ideas however were met with major resistance from Xerox management.

Starkweather was told by his bosses to stop working on the laser printer project. But he couldn't. He had to go through with this idea. He ended up working on it covertly, convincing people to get different parts for him so he could build it. The prototype was ready in 1969, built by modifying an existing xerographic copier. Starkweather disabled the imaging system and created a spinning drum with 8 mirrored sides, with a laser focused on the drum. Light from the laser would bounce off the spinning drum, sweeping across the page as it traveled through the copier. The hardware was completed in just a week or two, but the computer interface and software took almost 3 months to complete. The time has shown that Xerox management was wrong in that assumption: Printers now are a pillar of the company's growth strategy. Indeed, Starkweather's drive to create the laser printer eventually transformed a small copier company into one of the world's imaging powerhouses,and revolutionized the computer printing industry. Salvation for Starkweather came in 1970 when Xerox build the Palo Alto Research Center (PARC) in California. Starkweather called PARC and was welcomed, his project appeared to be a natural fit into their long-range plans.

Out of hostile territory and finally given the freedom to conduct his research without fear of retribution, Starkweather went to work on building the laser printer. In 1971, just nine months after joining PARC, Starkweather completed the first working laser printer.He named this machine SLOT, an acronym for Scanned Laser Output Terminal. The digital control system and character generator for the printer were developed by Butler Lampson and Ronald Rider in 1972. The combined efforts resulted in a printer named EARS (Ethernet, Alto, Research character generator, Scanned laser output terminal). The EARS printer was used with the Alto computer system network and subsequently became the Xerox 9700 laser printing system.

Gradually the things took off, and by 1973 Starkweather's group had working models of this thing at the facility. The final result—the Xerox 9700 (see the lower image), introduced in 1977, was the industry's first commercial laser printer. It was a wild success, despite projections that few customers would produce the 200000 to 300000 prints per month needed for the unit to be profitable.

Fresh off the success of the 9700, Starkweather shifted his research onto personal laser printers,and again ran into opposition from Xerox. Xerox was a company that liked large, fast laser printers. They saw departmental units as the profit center for laser printer technology.

Xerox failed to connect the dots and realize that the profit wasn't in the printer but in the toner and the paper. As a result, the company was beaten to market by Hewlett-Packard, which introduced the first personal laser printer in 1980.

Xerox had an interesting capability that has always been characteristic of the company, and that is that it always encouraged new ideas but never really liked to pursue them for very long. Things like Postscript, the laser printer, the personal computer, the bitmapped screen, the iconic interface, Ethernet, packet switching, all of this came out of PARC. And none of it, ended up as a product of Xerox.

Starkweather did see the writing on the wall at Xerox, however, and left the company in 1987 after 24 years of service. Following a 10-year stint at Apple Computer, Starkweather joined Microsoft Research in 1997. These days, his main area of research is display technology.

CASE STUDY

LABEL PRINTERS WITH LAN CONNECTION

"With the SATO printers, we no longer have to worry about prolonged interruptions, as SATO's CL408e model integrated well into our network. If a label printer were to fail now, there would be virtually no downtime. Staff can fall back on any other SATO printer in the network and print the barcode labels on whichever nearby network printer they wish."

When asked why the German brewery Bitburger Brauerei decided to use label printers by SATO, Herbert Dahmen, IT Project Coordinator at Bitburger, simply answers by stating three qualities: "Versatile, fast and reliable." These are the criteria the label printers had to meet that were to replace the old labelling system at Bitburger Brauerei, both in the laboratory and in production. In terms of meeting these three requirements, only the SATO CL408e printer was able to satisfy Bitburger's IT experts. "Our old printing systems may still have been relatively reliable, but they weren't fast enough and certainly not versatile enough. For example, they had a normal printer connection that ultimately made only one local connection possible through one single computer," comments Dahmen, and goes on to describe the problem: "If a printer broke down, a replacement had to be found quickly. The outputs of all printers add up to a print volume of roughly 3,400 to 6,800 labels per day. This means that printing stoppages would place an enormous burden on operations. With the SATO printers, we no longer have to worry about prolonged interruptions, as SATO's CL408e model integrated well into our network. If a label printer were to fail now, there would be virtually no downtime. Staff can fall back on any other SATO printer in the network and print the barcode labels on whichever nearby network printer they wish."

SATO's barcode label printers are now being used at the Bitburger laboratory to apply labels to Petri dishes, flasks and test tubes. "Bottles containing beer samples are labelled at production level, too. It's tremendously important for examinations and quality controls that barcode labels are applied to the containers to ensure unambiguous allocation," IT Project Coordinator Dahmen emphasizes. The brewery distinguishes between two different label types. There are the so-called "sample labels;" the only information they contain is the barcode with the sample number. Other labels, which have a barcode with information on the sample number and identification number of the respective analysis, are referred to as "parameter labels." With this system, once the barcode has been read using the hand scanner, the laboratory or production employee is automatically led, in the laboratory data system, to the place where the analysis values are to be input.

The previous label printers were not flexible in terms of their possible use due to their limited interface selection. This is to say that every computer in the production and laboratory area of Bitburger Brauerei could print only on the printer that was connected to it locally. In the past, this sometimes resulted in the fact that, when a printer was down, printing processes were inevitably held up. The solution was obvious to IT Project Coordinator Dahmen: the old label printers had to be replaced by network-compatible label printers. An equally important aspect for Dahmen was that the same printers were installed in both areas. "It would not have made a great deal of sense for our project to merely replace individual printers. To enable staff members to access the individual printers in the production or laboratory area from any workplace, it was important to integrate identical printer models into the network. This will also eliminate the occurrence of driver problems in the future and guard against possible incompatibilities. For a company the size of Bitburger Brauerei," IT Project Coordinator Dahmen points out, "trouble-free operation is of outmost importance."

Founded in Bitburg in 1817, Bitburger is today one of Germany's biggest beer manufacturers with an output of more than 4 million hectoliters per year. The Bitburger Brauerei company belongs to beverages group Bitburger Getränkegruppe. Besides the producers of Gerolsteiner mineral water, the Bitburger Holding GmbH combines renowned breweries such as König, Köstritzer, Licher and Wernesgrüner under one roof.

One of the foremost criteria in deciding to introduce new label printers was the possibility of using the Bitburger Brauerei network as printer interface. Dahmen and his team had previously tested a number of models from other providers and found that they reacted with long response times in the network. "Obviously, this was not acceptable. For us, network compatibility and speed must not rule each other out. That's why we asked Mr Bollenbach at WWP to select a new network compatible industrial printer," the IT expert explains. WWP GmbH from Rheinbach specializes in tagging and identification systems, and is an authorized partner of SATO. Given the positive experience he had with SATO over many years, WWP's Managing Director Guido Bollenbach decided to propose the CL408e model to Bitburger Brauerei. Bollenbach justifies his recommendation by the fact that SATO's printers are equal to industrial requirements in many respects: "Various factors argue in favour of this choice. For one thing, SATO printers are special printers that are extremely robust and reliable. For another, they are equipped with a fast processor that ensures rapid data processing and therefore a high printing speed. What's more, the SATO CL408e offers so many interfaces that it can be integrated into just about any environment – simply perfect for Bitburger Brauerei."

Before WWP delivered the 17 printers, tests had to be run to determine whether the SATO CL408e model could be easily integrated into the network at Bitburger Brauerei. A pilot installation was carried out. "We initially delivered one label printer. A SATO technician was on hand to install the printer in the Bitburger network and instruct staff members," says WWP Managing Director Bollenbach. The installation was followed by exhaustive tests that were conducted by Bitburger's laboratory and production employees over four weeks. "We wanted to be absolutely sure, and tried out everything," explains Bitburger's IT specialist Dahmen. "This involved printing on the most varied of labels. We experienced no problems whatsoever. But if a question did pop up, Mr Bollenbach and SATO were there to provide the necessary assistance. In the end, we were more than satisfied with the SATO printer.

"WWP supplied the 17 printers very quickly. We had the industrial printers on the premises in just a few days. But we replaced the old printers with the new SATO models successively. A number of preparations had to be made involving the LAN connections within the production plant. When the printers were delivered, not every workplace had a network connection." Thanks to the extensive network preparations it was possible to equip the laboratory with the CL408e printers very quickly. In production, by contrast, it took roughly five weeks to integrate the new label printers. Since then, five of the label printers are in operation in the laboratory and twelve are used in production. WWP Managing Director Guido Bollenbach himself conducted an afternoon training session and explained all that needed to be known about handling the SATO CL408e model. "One can really tell that the employees of Bitburger are highly qualified. It only took us a few hours to explain the functions and possibilities of the SATO printers to the laboratory and production staff", reports Bollenbach.

Everyone concerned at Bitburger Brauerei is certain that a more flexible and efficient mode of operation was made possible by the network integration of the 17 SATO printers. With this optimal solution, the brewers are now ready for any failures of individual printers that might occur. IT Project Coordinator Dahmen sums up as follows: "If, contrary to expectations, there was a stoppage because a label printer failed, another SATO label printer would simply take its place. It is no longer necessary to replace the printers straightaway, with the result that no downtime arises. What's more, the high-speed data processing that the network printers offer ensures faster operation processes. It's just what we want – versatile, fast and reliable."

SUMMARY

- A printer is an external hardware output device that takes the electronic data stored on a computer or other device and generates a hard copy.
- A printer is a device that accepts text and graphic output from a computer and transfers the information to paper, usually to standard size sheets of paper. Printers are sometimes sold with computers, but more frequently are purchased separately.
- External device that communicates with another digital device to print what a user sees on a screen. Printers use small pixels to transfer an image from the system to another surface.
- Printer languages are commands from the computer to the printer to tell the printer how to format the document being printed. These commands manage font size, graphics, compression of data sent to the printer, color, etc.
- A font is a set of characters of a specific style and size within an overall typeface design. Printers use resident fonts and soft fonts to print documents. Resident fonts are built into the hardware of a printer.
- A dot matrix is a 2D matrix of dots that can represent images, symbols, or characters. They are used for electronic displays, such as computer monitors and led screens, as well as printed output.
- An inkjet printer is a computer peripheral that produces hard copy by spraying ink onto paper. A typical inkjet printer can produce copy with a resolution of at least 300 dots per inch.
- A laser printer is a popular type of personal computer printer that uses a non-impact (keys do not strike the paper), photocopier technology.
- The laser printer is different from an inkjet printer in a number of ways. The toner or ink in a laser printer is dry. In an inkjet, it is wet. Over time, an inkjet printer is about ten times more expensive to operate than a laser printer because ink needs replenishing more frequently.
- Run the printer-cleaning page to keep the fuser free of toner and paper particles that can sometimes accumulate. Accumulation of toner and particles can cause specks to appear on the front or backside of print jobs.
- In addition to testing the printer using the printer self-test Microsoft Windows users can also perform software self-test to determine if their computer can see the printer and it is able to print.

KNOWLEDGE CHECK

1. **dot matrix' and 'solid font' printers are examples of**
   a. line printers
   b. of-band printer
   c. character printer
   d. ink printers
2. **'ink-jet printers' or 'band printers' are classified as**
   a. character printer
   b. ink printers
   c. line printers
   d. of band printer
3. **Printing technique in which characters are produced using metals pieces is called**
   a. matrix font
   b. solid fonts
   c. page font
   d. paragraph font
4. **Printer in which printing head and paper is forced together to form letters is called**
   a. impact printer
   b. non impact printer
   c. page printers
   d. line printers
5. **Per minute printing speed of large laser printer is**
   a. 150 pages
   b. 200 pages
   c. 250 pages
   d. 300 pages
6. **Printer in which output is printed by using light beam and particles of ink infused on paper is best classified as**
   a. character printer
   b. line printers
   c. laser printer
   d. beam printer

7. **Which of the following devices gives the paper a positive charge?**
   a. The laser
   b. The print drum
   c. The registration rollers
   d. The transfer corona wire
8. **Why is the print drum given a negative charge?**
   a. To attract the toner to every area of the drum
   b. To attract the toner to the areas of the drum that have a stronger negative charge
   c. To attract the toner to the areas of the drum that have a weaker negative charge
   d. To attract the positively charged paper to the print drum

REVIEW QUESTIONS

1. Explain the overview of printers.
2. What do you mean by current printer technologies?
3. What is dot matrix printer? Explain in brief.
4. Differentiate between inkjet printer and laser printer.
5. How can installing a printer on windows PC? Explain
6. Differentiate between local printers and network printers.
7. Discuss about basic laser printer care and maintenance.

Check Your Result

1. (c)	2. (c)	3. (b)	4. (a)	5. (a)	6. (c)
7. (d)	8. (c)				

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CHAPTER 8

POWER SUPPLIES AND CASES

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Elaborate the Factors of Power Supplies
2. Know the Computer Cooling System Solutions

"Electricity is but yet a new agent for the arts and manufactures, and, doubtless, generations unborn will regard with interest this century, in which it has been first applied to the wants of mankind."

—Alfred Smee

INTRODUCTION

A power supply is the hardware component that provides electricity to power computers and other devices. It converts electrical current pulled from a power source, such as an outlet, battery or generator, to the correct format and passes it on to a device. It also regulates the voltage passed through to the machine to prevent overheating. Power supplies are sometimes abbreviated as PS or P/S, PSU (power supply unit).

Power supplies are rated in terms of the number of watts they generate. The more powerful the computer, the more watts it can provide to components.

Power supplies convert the formats of electricity pulled from power sources to match the format required by the machines they power. There are two main types of power supplies that differ according to the conversion. The most common type of power supply converts alternating current (AC) from the power source to direct current (DC), called AC-DC power supplies. DC-DC power supplies are less common. They are often used to plug electrical devices into battery power sources, such as car outlets, or other sources that supply DC current. Overall, the majority of power sources supply AC.

Power sources emit a consistent output voltage. However, some devices require more voltage to operate, while others that require a lower level of voltage may not be able to handle that output without overheating. Power supplies increase or decrease the voltage output to match a given machine's requirements.

Power supplies consist of four main components that each carry out a specific function:

- Transformers regulate the incoming voltage. They either step up or step down the voltage to match a device's requirements.
- Rectifiers convert the incoming AC to DC. These come as either half-wave, full-wave or bridge.
- Filters smooth out the waves in the current after it's converted to DC. The unregulated power outputted from the filter is much smoother but not completely flat.
- Voltage regulators finish the job of the filter by reducing any leftover ripples in the voltage that could lead to drops in power or overheating.

8.1 FACTORS IN POWER SUPPLIES

The shape and general physical layout of a component is called the *form factor*. Items that share a form factor are generally interchangeable, at least as far as their sizes and fits are concerned. When designing a PC, the engineers can choose to use one of the popular standard PSU (power supply unit) form factors, or they can elect to build their own. Choosing the former means that a virtually inexhaustible supply of inexpensive replacement parts will be available in a variety of quality and power output levels. Going the custom route means additional time and expense for development. In addition, the power supply is unique to the system and available only from the original manufacturer.

In addition to coming in different styles, cases also come in different form factors. The form factor describes the general layout of the case, the positioning of the slots in the back of the case, and the way that the case matches to the major components that fit into it. In particular, there are three main components that must be matched in terms of their form factor: the case, the power supply, and the motherboard. Usually, when you buy a system case it comes with a power supply, so matching the case and power supply is not a concern, but that is not always the case. In addition, some case form factors can work with more than one power supply form factor.

The most popular case form factors today are the “Baby AT”, ATX, and NLX, with the newer microATX/SFX form factor also being used increasingly on lower-end systems. (Baby AT systems are now obsolete but there are so many millions of them in use that they remain a factor, especially in the upgrade and repair market.) These cases are not interchangeable, since they are shaped differently, and require motherboards with a different form factor. If you are building your own system you must ensure your motherboard and case/power supply form factors match. There are cases that can handle both baby AT and ATX motherboards.

The most common system case type is the tower. Depending on the specific number of internal drive bays and the height of the tower, these cases can be further classified into mini-size, mid-size and full-size tower cases. One of the biggest considerations when choosing between case sizes is the number of slots and the number of devices we would like to add to those cases.

Full Tower

Full-tower cases are generally big with a height that is about or more than 30 inches (more than 76 cm). The number of internal drive bays inside these cases can be between 6 and 10.

Mid Tower

Another case that might be a step down, would be classified as a mid-tower case. Mid-tower cases are the most widely used computer cases. Mid Tower cases are about 18 to 24 (45 to 60 cm) inches high and they usually contain 2 to 4 internal drive bays and a similar number of external bays (for CD/DVD readers and similar).

Mini Tower

Mini-tower usually have up to 2 or sometimes 3 internal drive bays. Mini-cases normally stand at a height of 12 to 18 inches (30 to 45 cm). Expandability is a problem with these cases.

Slim Line Case

Slim line cases are simply tower cases turned on their sideways. They can hold a monitor on top of the case.

Small Form Factor (SFF) Case

Small form factor or SFF cases are custom cases that are designed to minimize the spatial volume of a desktop computer. SFFs are available in a variety of sizes and shapes, including shoe boxes, cubes, and book-sized PCs.

Keyword

Small Form Factor: It is a computer form factor designed to minimize the volume of a desktop computer.

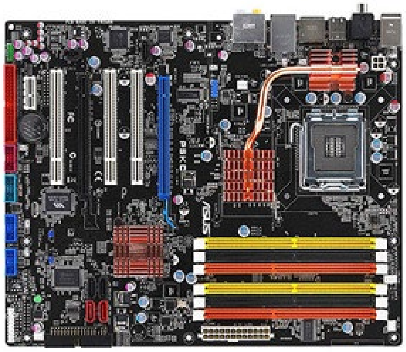
Motherboard Form Factor

There's one important consideration we need to be aware of when choosing the case size and that is the size of the motherboard. They need to match. The size of the motherboard is often called the Form Factor and there are several standards. The form factor identifies the size of the circuit board, the location of the slots as well as the location of the faceplate that comes out the back of the computer. The form factor also identifies the location of the holes that are used to mount the motherboard into the system case.

The full tower has more than enough room to fit an ATX motherboard. Mid-tower case can also accommodate an ATX motherboard in most cases.

ATX Form Factor (Full ATX)

Probably the most common form factor for a motherboard is the ATX form factor. The board is approximately 12″ x 9.6″ (30cm x 24cm).

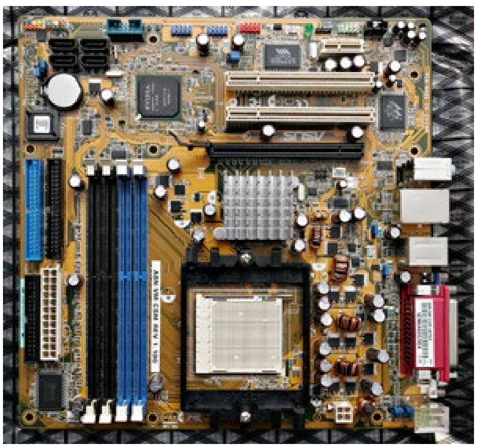


Mini ATX

A mini-ATX motherboard is a slightly smaller variation of the full ATX size that measures 11.2″ x 8.2″ (28cm x 21cm). The main difference between ATX and mini-ATX is the number of buses and possibly memory slots on the motherboard. Mounting holes for both are located in the same place, making them interchangeable in most cases. A case that supports an ATX motherboard can also support mini-ATX motherboard.

Micro ATX

The micro-ATX form factor is an even smaller version of the ATX standard, with a maximum size of 9.6″ x 9.6″ (24cm x 24cm). The faceplate line up to the exact same position as in all other versions of ATX. System case that can hold an ATX motherboard can also hold micro ATX motherboard. The smaller mid or mini tower cases would likely be too small for a full ATX motherboard but should accommodate micro ATX motherboard. The terms mini-ATX and micro-ATX are often used interchangeably.



Flex ATX

The size of **Flex ATX** is 9′′ x 7.5′′ (22,9 cm x 19,1 cm). It is derived from Micro ATX and is used in small computer cases.

> **Keyword**
>
> **Flex ATX:** It is a motherboard form factor derived from ATX.

Mini ITX

Going down in size we have a mini ITX motherboard with a maximum size of 6.7″ x 6.7″ (17cm x 17cm). Notice that there is a single expansion slot and the motherboard itself is considerably smaller than the ATX and even the micro ATX. Also notice that the faceplate still line up and the whole positions still match the ATX hole positions. Theoretically we could take this micro ITX motherboard and place it inside a full tower case. However we usually use a small form factor case for this motherboard.

Em ITX

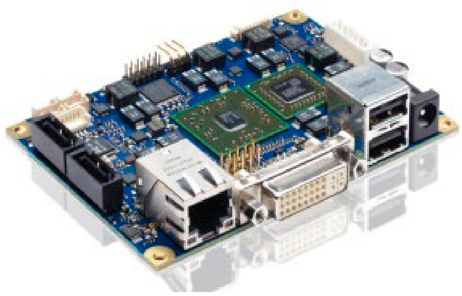
Em ITX dimensions are 17 cm x 12 cm.

Nano ITX

Measures of Nano ITX are 4.7" x 4.7" (12 cm x 12 cm). It is used with smaller devices like set-top boxes, car PCs, media centers, and other embedded devices.

Pico ITX

The size of the Pico ITX is 3.9'' x 2.8'' (10 cm X 7,2 cm).



Mobile ITX

Mobile ITX is the smallest form factor with the size of 2.4'' x 2.4'' (6 cm x 6 cm).

The ATX form factor and its variations are the most common motherboard form factors.

DTX Form Factor

DTX form factor is intended for small form factor PCs, and is backward compatible with ATX form factor cases. Dimensions are 8′′ x 9.6′′ (20,3 cm x 24,4 cm).

DTX Form Factor: It is a variation of ATX specification designed especially for small form factor PCs (especially for HTPCs) with dimensions of 8 × 9.6 inches (203 × 244 mm).

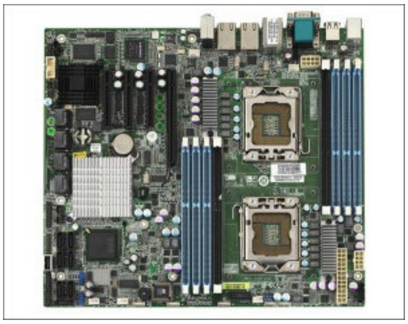
Mini DTX

Mini DTX is a shorter version of DTX form factor. Dimensions are 8′′ x 6.7′′ (20,3 cm x 170 cm).

SSI CEB

SSI form factors were developed by SSI (Server System Infrastructure) forum, and are intended for dual or multi-processor motherboards used in servers and or even workstations. SSI form factors were derived from ATX specification, so they have the same rear panel, IO connector area, and mounting holes. But, SSI form factors are larger than ATX, so SSI motherboards will not fit cases designed for standard ATX. The computer case has to be designed for larger than standard ATX form factor.

Three SSI form factors are CEB (Compact Electronics Bay), EEB (Enterprise Electronics Bay), and MEB (Midrange Electronics Bay). The smallest of them is SSI CEB, and the size is 12′′ x 10.5′′ (30,5 cm x 26,7cm).



SSI EEB (also called Extended ATX or E-ATX)

SSI EEB dimensions are 12′′ x 13′′ (30,5 cm x 33 cm).

SSI MEB

The SSI MEB size is 16.2′′ x 13′′ (41,1 cm × 33 cm). It is longer in order to provide space for two additional CPU sockets.

BTX Form Factor

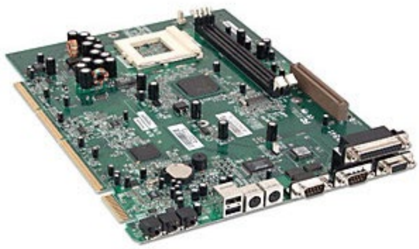
There are a few main differences with the **BTX form factor**. Notice that the faceplate is on the opposite end. Another difference is that the whole positions are different. Also, the processor socket is slightly rotated so that it is at an angle to the system board. This rotation is to aid in the airflow across the processor to assist in cooling the processor. The BTX motherboard will only fit within a system case that is designed for a BTX motherboard. In many cases this means that an ATX system case will not work with a BTX system board, although there are system cases that are able to accommodate both the ATX and the BTX form factors. The BTX form factor has not been widely adopted despite its improvements over ATX and related standards. As a result, the availability and variety of BTX-compatible components is limited.

Keyword

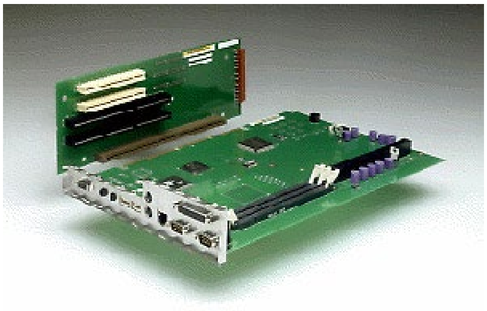
BTX Form Factor: It is a form factor for motherboards, originally intended to be the replacement for the aging ATX motherboard form factor in late 2004 and early 2005.

NLX Form Factor

The NLX is an older style form factor that is not used very often anymore. We might see it in some older motherboards but it is not likely to encounter it with newer motherboards.



NLX is an older form factor used for slim line desktop-style computers. NLX is an improvement over an even earlier LPX form factor. Notice that this motherboard has no expansion slots for the PCI or ISA bus. The NLX form factor is used in slim line cases that are very short.



In order to accommodate expansion cards we use a tab on the edge of the motherboard. We insert a Riser Card on the end of the motherboard. Riser Card is then used for expansion cards, so that now expansion cards lay flat rather than being perpendicular to the motherboard. The riser card does not have built-in ports for audio, joystick, USB, network or modem.

Tower cases are: Full tower, Mid tower and Mini tower. Slim line cases are simply tower cases turned on their sideways. Small form factor or SFF cases are custom cases that are designed to minimize the spatial volume of a desktop computer. The size of the motherboard is often called the Form Factor. The most common form factor for a motherboard is the ATX form factor. When considering the size of ATX we differentiate Full ATX, Mini ATX, Micro ATX, Flex ATX, Mini ITX, Em ITX, Nano ITX, Pico ITX, and Mobile ITX. SSI CEB, SSI EEB, SSI MEB form factors are larger than ATX. When comparing with ATX, BTX form factor has the faceplate on the opposite side, whole positions are different and the processor socket is slightly rotated. The BTX motherboard will only fit within a computer case that is designed for a BTX motherboard. The NLX is an older style form factor that is not used very often anymore.

Power Supply Wattage

A 400-watt switching power supply will not necessarily use more power than a 250-watt supply. A larger supply may be needed if you use every available slot on the motherboard or every available drive bay in the personal computer case. It is not a good idea to have a 250-watt supply if you have 250 watts total in devices, since the supply should not be loaded to 100 percent of its capacity.

According to PC Power & Cooling, Inc., some power consumption values (in watts) for common items in a personal computer are:

- Accelerated Graphics Port (AGP) card = 20 to 30W
- Peripheral Component Interconnect (PCI) card = 5W
- small computer system interface (SCSI) PCI card = 20 to 25W
- network interface card = 4W
- 50X CD-ROM drive = 10 to 25W
- RAM = 10W per 128M
- 5200 RPM Integrated Drive Electronics (IDE) hard disk drive = 5 to 11W
- 7200 RPM IDE hard disk drive = 5-15W
- Motherboard (without CPU or RAM) = 20 to 30W
- 550 MHz Pentium III = 30W
- 733 MHz Pentium III = 23.5W
- 300 MHz Celeron = 18W
- 600 MHz Athlon = 45W

Power supplies of the same form factor ("form factor" refers to the actual shape of the motherboard) are typically differentiated by the wattage they supply and the length of the warranty.

REMEMBER

When choosing a system case, other than considering the size of the computer that we want, the most important thing is to match the motherboard form factor with the form factor supported by the computer case. The most common system case type is the tower.

8.2 COMPUTER COOLING SYSTEM SOLUTIONS

A computer system is comprised of electronic components such as a central processing unit, RAM, motherboard, and more. As new computers become ever more advanced and are coaxed to work faster, more heat is produced by these electronic components.

Required to compute more, modern systems require increased cooling and ventilation capabilities to move air through the unit, dissipating excess heat and keeping the components working within safe operating temperatures. Cooling and dissipation of heat, especially around the central processing unit, is always a cause for concern as the temperature of the interiors of a PC increase due to the amount of heat generated by the central processing unit. Excess heat that is not removed by sufficient cooling can negatively impact the normal functioning of the central processing unit and can cause circuits and components to become unstable. If the temperature increases beyond a certain threshold, then the heat interferes with the proper functioning of the PC and can cause serious malfunctions. Without a proper computer cooling system, the PC's electronic components may not be able to function optimally and the integral parts of what makes the computer work could even be damaged. Overheating can reduce the lifespan of computer components and peripheral units and can lead to data loss and irreparable damage. Processor types and other factors determine the safe thermal operating range, a range that varies from computer manufacturer to manufacturer.

Keyword

Cooling Computer Systems: It is required to remove the waste heat produced by computer components, to keep components within permissible operating temperature limits.

8.2.1 Cooling Computer Systems

To remove excess heat from a computer system, a thermal management cooling system is used. Typically, a heat sink is employed with a computer's central processing unit to increase the heat dissipation area for more effective cooling. Heat sinks have thermal conductors that draw heat away from a component, such as a processor, and carry it into fins that provide a large enough area for heat to dissipate and sufficient cooling to take place. Active heat sinks incorporate a fan to keep the processor cool. There are two types of heat sinks: active and passive. Active heat sinks make use of power to run the cooling fan to cool down the system and allow concentrated, dedicated cooling of the processor, while passive heat sinks dissipate heat through convection. To get the best results from active cooling, quality fans with ball bearings must be chosen to give top performance, and for passive cooling to work efficiently, the machine must be placed in an area where there's a steady flow of air moving across the fins.

Cooling fans are used to blow cool air over the heat-generating components in a computer and to draw the accumulated hot air away from the area around the components, thus lowering the temperature of the air surrounding the components while allowing more heat to be radiated out of the case.

Using Cooling Fans in Computers

Air-cooling with fans is one of the most widely practiced ways of dissipating heat in computers. Fans are not only easy to install and maintain, but are also an effective way to remove heat from components and bring in cooler air, thus maintaining a constant optimal temperature for operation. Fan sizes, types, and placements play an important role in the efficient dissipation of heat. The most common sizes for computer fans, which are typically square devices, include 60mm, 80mm, 92mm, and 120mm. Some of the types of cooling fans often installed in computers include:

CPU fans, which are used in conjunction with heat sinks to prevent overheating of the components in central processing units.

Case fans, which cool the surrounding area by circulating fresh air through the case by drawing out hot air, drawing in cooler air, or both.

Hard drive fans, which are often used in systems with heat-production challenges from a lot of hard drive usage.

There are many types of solutions that can maintain the high reliability of a computer's electronic components. However, leaving the decision about a computer cooling system until the end of the design process can prove to be costly in terms of larger or more expensive solutions. Instead, consider all your temperature regulation options at the initial stages of development to reduce costs while improving design layout and establishing high reliability.

Keyword

CPU Fans: It is any fan inside, or attached to, a computer case used for active cooling, and may refer to fans that draw cooler air into the case from the outside.

Keep PC from Overheating

Apart from choosing the right cooling devices for your PC, you can also increase the lifespan of the components, avoid overheating, and improve reliability by taking measures such as maintaining a clean, dust-free operating environment for your computer.

The inside of a PC should be cleaned thoroughly at least once every six months, as dust build-up can lead to heating problems. In fact, dust accumulation is one of the main causes of premature system malfunctions and reliability problems. Dust acts as an insulation blanket that prevents heat from escaping. This can cause the system to overheat. Make sure you clean the inside of the CPU, including the fans on the top of the CPU, the filters of fans, and the fan located on top of the power supply.

Computer Cooling System Solutions from NMB

Drawing on our extensive experience in the manufacturing of bearings, one of the main components a cooling fan relies on to work effectively, NMB manufacturers reliable, smoothly operating, and long lasting products to keep your computer system cool.

8.2.2 Power Supply Fan

Keeping your system cool is very important, and, therefore, one of the most important components in your power supply system can be a fan. Different iterations of the power supply fan have been cooling computers since the time PCs first came out. Modern day computers now have additional cooling methods to keep the system from overheating, such as CPU cooling fans and auxiliary fans, but fans for power supplies continue to be a critical cooling device in maintaining the overall system temperature balance. With faster and hotter processors becoming the norm, maintaining optimal temperatures is critical for the smooth running of any system, and overheating of a system often causes irreparable damage to the equipment, often leading to data loss. A fan can provide the air flow required to cool the components. In systems that require more cooling, more fans are generally used. Typically, fans are located towards the back of the power supply. There are specially designed cases with vents that allow better air flow through the system in which the power supply fan can either blow out the air from the back or draw in cooler air, depending on the design of the system. In both these instances, the flow of air should be smooth without any interruptions or blockages.

Size of Regular and Auxiliary Fans

Both regular and auxiliary fans can be found in a power supply. Which type and size of fan is right for a given system depends upon that system's specific requirements and design. The standard size of a square computer cooling fan is about 80mm; however, other sizes such as 60mm, 92mm, and 120mm can be chosen as required. Fans may be placed in various specially designed vents around a power supply.

What Determines the Quality of a Power Supply Fan?

The quality of construction is one of the most important determining factors to the quality of a fan. This involves the quality of construction that has gone into the motor and its bearings. Bearings reduce friction and allow a fan to operate at high speeds. There are typically two types of fan bearing types: ball bearings and sleeve bearings. Ball bearings have more longevity and cost more, sleeve bearings may be less expensive and their life expectancy is considered much less than a quality ball bearing

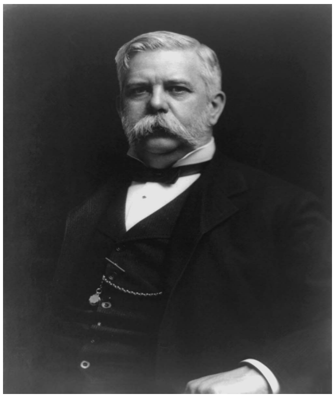
Fan Speeds to Dissipate Heat in a Power Supply

Some systems can control the speed of their fans. Power supplies may have automatic thermal control of a fan, which indicates when the power supply's fan should turn on or off and increase or decrease its speed according to the system's temperature. The speed of the fan is determined by the amount of airflow it can move, which is measured in cubic feet per minute or CFM. The higher the CFM, the more air the power supply's fan is capable of distributing. Usually, around 70 CFM is a good starting point. Smaller fans with higher CFMs usually produce more noise.

Causes of Power Supply Fan Failure

One of the main reasons why fan failure occurs in power supplies is debris and dust build up. Dust can get into the motors of fans and impede the proper flow of air. The average time until predictable failure steadily increases if the computer is kept in a dusty or dirty environment, or if the computer is not cleaned at least once in six months. If the fans in the power supply stop working, then overheating can occur in the power supply as well as the rest of the components inside the computer. In an attempt to protect your system from further damage, some systems will sound an alarm if the fans stop working, or will shut down the system altogether.

Choosing Your Power Supply Fan Before choosing a fan for your power supply, check what kind of system you have first in order to determine what types of fans you should be looking at and in which direction they should circulate air. Older power supplies may need fans designed to exhaust air out from the back while newer power supply fans reverse the flow of air to draw air into the supply case, achieving better control over the air that enters the system.



ROLE MODEL

JOHN DIXON GIBBS: INVENTED DEVICES FOR THE TRANSMISSION OF ALTERNATING CURRENT ELECTRICAL ENERGY.

John Dixon Gibbs (1834–1912) was a British engineer and financier who, together with Lucien Gaulard is often credited as the co-inventor of the AC step-down transformer. The transformer was first demonstrated in 1883 at London's Royal Aquarium. At the time the term "transformer" had not yet been invented, so instead it was referred to as a "secondary generator". Although he is usually credited equally with Gaulard, Gibb's role in the invention appears to have been more that of a financial backer and businessman.

Although the underlying physics of the transformer, mainly Faraday's law of induction, had been known since the 1830s, transformers only became viable after the introduction of Gaulard and Gibbs's transformer design in 1883. The breakthrough was to build an iron transformer core which could act as a magnetic circuit. At the time, their invention was seen as overcomplicated since it contained a movable armature. It caught the attention of Sir Coutts Lindsay, who used it to power the Grosvenor Gallery, which was one of the first lighting systems in Britain powered by a central generating station.[4] In 1885 Ottó Bláthy, Miksa Déri and Károly Zipernowsky secured a patent on a similar design, using laminated sheets of metal to reduce eddy currents.

Information on an exhibition of Gibbs and Gaulard's transformer in Turin, Italy in 1884 was published in 1885 and caught the attention of George Westinghouse. In the summer of 1885 Westinghouse bought the American rights for Gibbs and Gaulard's design and ordered that several transformers from Gibbs and Gaulard be purchased and shipped to his factory in Pittsburgh. Westinghouse then asked the engineer William Stanley, Jr. to design an electric lighting system using them. Stanley subsequently greatly improved on Gibbs and Gaulard's design and is often credited in their place.

John Dixon Gibbs had his work patented under German patent no. 28947, a patent also recognized in Great Britain. The patent was disputed by Sebastian Ziani de Ferranti. Following patent litigation, Gibbs and Gaulard lost the patent. Gibbs appealed the suit, taking the case all the way to the House of Lords, where he again lost. He was financially ruined in the process.

CASE STUDY

TWO-PHASE COOLING SAVES COMPUTER POWER

Cooling data centers in the U.S. consume a huge amount of energy—up to 50 percent of total operating costs. But cooling is also absolutely essential. If the racks of computers overheat, they get sluggish or, even worse, shut down.The standard cooling approach is to use basic air conditioning to cool the space that houses the servers. Overall, this is an inefficient process because air has a low density and low specific heat. Another alternative is using a liqu id cooling system. This requires customized servers (more expensive) or the introduction of water into the server chassis, which makes data-center managers very uneasy, because even a drop or two of leaked water can seriously damage the electronics.

Now, however, Tim Shedd, an associate mechanical engineering professor at the University of Wisconsin-Madison, has invented a cooling system that achieves a 90 percent cooling energy reduction at the chip by circulating a nontoxic, nonconductive, and nonflammable fluid that removes heat in the vapor phase. Shedd founded Ebullient Cooling in 2013 to further develop and market this technology.

Bubbles to the Rescue

Shedd's technology is based on two-phase cooling. The fluid is pumped through a tube and collides with a copper plate that is mounted to the computer chip that is enclosed within a plastic chamber. The fluid absorbs heat from the chip and begins to evaporate. The bubbles, which have captured the heat, are transported through a tube to the roof, where it is released, and the liquid phase is cooled down and recirculated to repeat the process. "The phase change gives us a big advantage because it can take a lot more heat away when we let the liquid boil, compared to the liquid just flowing through," says Shedd. "The boiling behavior also improves the cooling efficiency, allowing us to cool even the most intense heat sources with outside air exceeding 120 degrees Fahrenheit. Phase change also allows us to cool 2,000 watts or more per server."

Shedd selected a dielectric liquid refrigerant that would not damage the electronic equipment if it leaked. "You can literally dunk your phone or remote control in a cup of this working fluid and it has no negative effect," he says. Ebullient Cooling has also developed a way to 3D print the cooling modules that attach to the processors. Because they have superior thermal performance and low pressure loss, up to 10 devices can be cooled in series using a single cooling circuit connected with one-quarter-inch tubing.

Looking Ahead

Shedd is somewhat surprised by how well this laboratory idea has proven itself in the field.

"Typically it is difficult to translate what works in the laboratory to the real world because laboratory results depend on the tightly controlled operating conditions," says Shedd. "This technology, however, has proven to be very robust to environmental and operating variations due to inherent self-stabilizing behaviors and the patented flow-distribution system."

This technology has a wide range of applications. The greatest energy savings is in the data center cooling space, but other opportunities include cooling desktop computers, high heat flux laser diodes, LED lighting, and medical equipment such as MRIs and CT-scanners. Modified forms of the technology could also improve the efficiency of battery cooling and exhaust waste heat recovery.

"At the university, we are still working on the fundamentals of nucleation and heat transfer to 'sliding' bubbles, which we believe give our technology its high performance," says Shedd. "We are also uncovering methods for enhancing boiling without needing an enhanced surface. Being able to increase heat-transfer performance without the added cost of micro-machining a surface could be a real boon for heat-transfer devices."

SUMMARY

- A power supply is the hardware component that provides electricity to power computers and other devices. It converts electrical current pulled from a power source, such as an outlet, battery or generator, to the correct format and passes it on to a device.
- Power supplies convert the formats of electricity pulled from power sources to match the format required by the machines they power.
- Power sources emit a consistent output voltage. However, some devices require more voltage to operate, while others that require a lower level of voltage may not be able to handle that output without overheating.
- When designing a PC, the engineers can choose to use one of the popular standard PSU (power supply unit) form factors, or they can elect to build their own.
- The most common system case type is the tower. Depending on the specific number of internal drive bays and the height of the tower, these cases can be further classified into mini-size, mid-size and full-size tower cases.
- Slim line cases are simply tower cases turned on their sideways. They can hold a monitor on top of the case.
- Small form factor or SFF cases are custom cases that are designed to minimize the spatial volume of a desktop computer. SFFs are available in a variety of sizes and shapes, including shoe boxes, cubes, and book-sized PCs.
- The BTX motherboard will only fit within a system case that is designed for a BTX motherboard. In many cases this means that an ATX system case will not work with a BTX system board, although there are system cases that are able to accommodate both the ATX and the BTX form factors.
- Power supplies of the same form factor (“form factor” refers to the actual shape of the motherboard) are typically differentiated by the wattage they supply and the length of the warranty

KNOWLEDGE CHECK

1. A power supply which has voltage regulation of ………. is unregulated power supply

a. 0 %

b. 5 %

c. 10 %

d. 8%

2. Commercial power supplies have voltage regulation …………

a. of 10%

b. of 15%

c. of 25%

d. within 1%

3. A Zener diode is used as a …………… voltage regulating device

a. Shunt

b. Series

c. Series-shunt

d. None of the above

4. Over head lines for power supply to tramcars are at a minimum height of

a. 2 m

b. 5 m

c. 10 m

d. 15 m.

5. Which of the following might not be needed in a power supply?

a. The transformer.

b. The filter.

c. The rectifier.

d. All of the above are generally needed.

6. The typical value of SCR for modern alternator is

a. 1.5.

b. 0.5.

c. 1.0.

d. 1.2.

6. **In an unregulated power supply, if load current increases, the output voltage ………..**
   a. Remains the same
   b. Decreases
   c. Increases
   d. None of the above
7. **In an unregulated power supply, if input A.C. voltage increases, the output voltage …….**
   a. Increases
   b. Decreases
   c. Remains the same
   d. None of the above
8. **A power supply which has voltage regulation of ……….. is unregulated power supply**
   a. 0 %
   b. 5 %
   c. 10 %
   d. 8%

REVIEW QUESTIONS

1. Discuss about power supply unit.
2. Describe the factors in power supplies.
3. Understand the ATX form factor.
4. What determines the quality of a power supply fan?
5. Understand the fan speeds to dissipate heat in a power supply.
6. Describe the causes of power supply fan failure.

Check Your Result

1. (c) 2. (d) 3. (a) 4. (c) 5. (b) 6. (a) 6. (b)
7. (a) 8. (c)

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CHAPTER 9

INTERNETWORKING SYSTEM

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

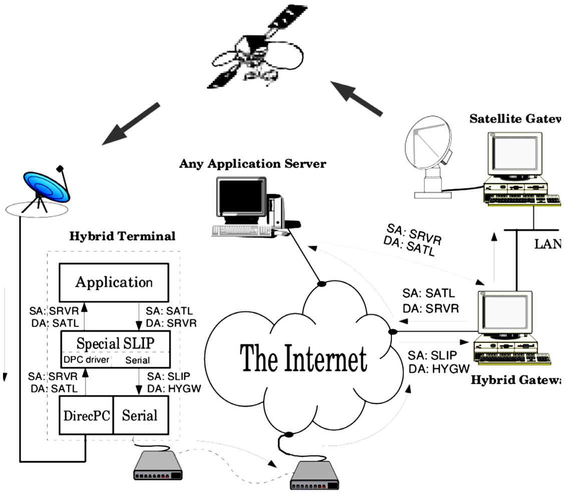
1. Discuss about the fundamental and principles of internetworking
2. Illustrate the internetwork architecture
3. Examine the IP addressing and architecture

> *"The internet could be a very positive step towards education, organization and participation in a meaningful society."*
>
> *—Noam Chomsky*

INTRODUCTION

Internetworking started as a way to connect disparate types of computer networking technology. Computer network term is used to describe two or more computers that are linked to each other. When two or more computer LANs or WANs or computer network segments are connected using devices such as a router and configure by logical addressing scheme with a protocol such as IP, then it is called as computer internetworking.

In modern practice, the interconnected computer networks or Internetworking use the Internet Protocol. Two architectural models are commonly used to describe the protocols and methods used in internetworking. The standard reference model for internetworking is Open Systems Interconnection (OSI).



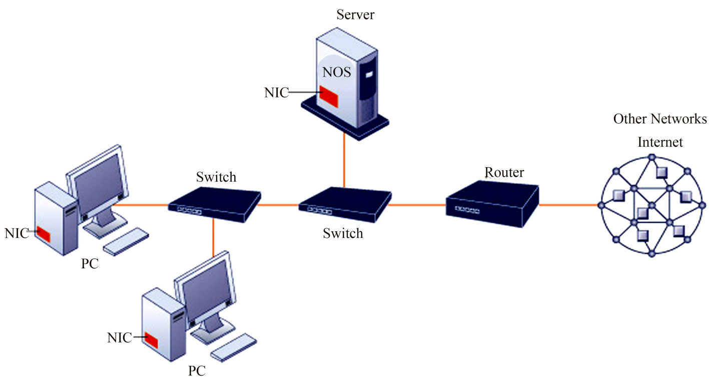
Internetworking is a term used by Cisco, BBN, and other providers of network products and services as a comprehensive term for all the concepts, technologies, and generic devices that allow people and their computers to communicate across different kinds of networks. For example, someone at a computer on a token ring local area network may want to communicate with someone at a computer on an Ethernet local area network in another country using a wide area network interconnection. The common internetwork protocols, routing tables, and related network devices required to achieve this communication constitute internetworking.

The standard reference model for internetworking is Open Systems Interconnection (OSI), which could also be used as a model for intranetworking as well. OSI enables any technology to be related to another technology because each can be related to the standard communication model. OSI provides a layering approach to the problem of exchanging data across a network or a network of networks so that the problem can be broken down into easier-to-understand components and so that boundaries between components can be more easily determined.

9.1 FUNDAMENTAL AND PRINCIPLES OF INTERNETWORKING

Internetworking is combined of 2 words, inter and networking which implies an association between totally different nodes or segments. This connection area unit is established through intercessor devices akin to routers or gateway. The first term for associate degree internetwork was catenet. This interconnection is often among or between public, private, commercial, industrial, or governmental networks. Thus, associate degree internetwork could be an assortment of individual networks, connected by intermediate networking devices, that functions as one giant network. Internetworking refers to the trade, products, and procedures that meet the challenge of making and administering internetworks.

To enable communication, every individual network node or phase is designed with similar protocol or communication logic that is Transfer Control Protocol (TCP) or Internet Protocol (IP). Once a network communicates with another network having constant communication procedures, it's called Internetworking. Internetworking was designed to resolve the matter of delivering a packet of information through many links.



There a minute difference between extending the network and Internetworking. Merely exploitation of either a switch or a hub to attach 2 local area networks is an extension of LAN whereas connecting them via the router is associate degree example of Internetworking. Internetworking is enforced in Layer three (Network Layer) of OSI-ISO model. The foremost notable example of internetworking is that the Internet.

9.1.1 Principle

Internetworking is the technique of interconnecting myriad networks together, using connecting devices like routers and gateways. The different networks are owned by different entities that widely vary in terms of network technologies. These networks may be public, private, government, business or academic in nature, whose sizes may vary from small LANs to large WANs. The resulting network of networks is generally termed as internetwork or simply internet.

Availability of different operating systems, hardware platforms and the geographical dispersion of the computing resources necessitated the need of networking in such a manner that computers of all sizes can communicate with each other, regardless of the vendor, the operating system, the hardware platform, or geographical proximity. Therefore, we may say that internetworking is a scheme for interconnecting multiple networks of dissimilar technologies. To interconnect multiple networks of dissimilar technologies use both additional hardware and software. This additional hardware is positioned between networks and software on each attached computer. Thus, system of interconnected networks is called an inter network or an Internet.

To find out a solution how to develop standards for internetworking, Defense Advanced Research Projects Agency (DARPA) had funded research projects in this direction. ARPA net - a project of DARPA - introduced the world of networking to protocol suite concepts such as layering, well before .ISO's initiative in this direction. DARPA continued its research for an internetworking protocol suite. This may be seen in the early NCP (Network Control Program) host-to-host protocol to the TCP/IP protocol suite, which took its current form around 1978.DARPA was well-known for its pioneering of packet switching over radio networks and satellite channels and ARPAnet was declared' an operational network with responsibility of administering it to Defense Communications Agency (DCA) in 1975. TCP/IP had not yet been developed.

ARPAnet was basically a network based on leased lines connected by special switching nodes, known as Internet Message Processors (IMP). Many researches were involved in TCP/IP research by 1979. This motivated DARPA to form an informal committee to coordinate and guide the design of the communication protocols and architecture. The committee was called the Internet Control and Configuration Board (ICCB).

The first real implementations of the Internet may be cited from the time when DARPA started converting the machines of its research network ARPAnet to use the new TCP/IP protocols. After this transition which started in 1980 and finished in 1983, DARPA demanded that all computers willing to connect to its ARPAnet must use TCP/IP. The US military adopted TCP/IP as standard protocol in 1983 and desired that all the networks connected to the ARPAnet were required to conform to the new standards.

The success of ARPAnet was more than the expectations of its own founders and TCP/IP internetworking became widespread rapidly. As a result, new wide area networks (WAN) were created in the USA and connected to ARPAnet using TCP/IP protocol. In turn, other networks in the rest of the world, not necessarily based on the TCP/IP protocols, were added to the set of interconnected networks. Computing facilities all over worth America, Europe, Japan, and other parts of the world are currently connected to the Internet via their own sub-networks, constituting the world's largest network. In 1990, ARPAnet was eliminated, and the Internet was declared as the formal global network.

DARPA also funded project to develop an implementation of the TCP/IP protocols for Berkeley UNIX on the VAX and to distribute the necessary code developed as the outcome of this project free of charge with their UNIX operating system. The first release of the Berkeley Software Distribution (BSD) to include the TCP/IP protocol set was made available in 1983 (4.2BSD). This led to the rapid spread of TCP/IP among universities and research centers and has become the standard communications subsystem for all UNIX connectivity. Many updated versions of BSD code are available. These are: 4.3BSD (1986), 4.3BSD Tahoe (1988), 4.3BSD Reno (1990) and 4.4BSD (1993).

9.1.2 Challenges to Internetworking

Implementing a useful internetwork isn't at any certainty. There are several challenging fields, particularly in the areas of dependableness, connectivity, network management, and adaptability and each and every space is essential in establishing associate degree economical and effective internetwork. Few of them are:-

- The initial challenge lies when we are trying to connect numerous systems to support communication between disparate technologies. For example, totally different sites might use different kinds of media, or they could operate at variable speeds.
- Another essential thought is reliable service that should be maintained in an internetwork. Individual users and whole organizations depend upon consistent, reliable access to network resources.
- Network management should give centralized support associate degreed **troubleshooting** capabilities in an internetwork. Configuration, security, performance, and different problems should be adequately addressed for the internetwork to perform swimmingly.
- Flexibility, the ultimate concern, is important for network enlargement and new applications and services, among different factors.

Keyword

Troubleshooting is a form of problem solving, often applied to repair failed products or processes on a machine or a system.

9.1.3 Internetwork Addressing

Internetwork addresses establish devices severally or as members of a bunch. Addressing schemes differ based on the protocol family and therefore the OSI layer. Three kinds of internetwork addresses area unit ordinarily used: data-link layer addresses, Media Access control (MAC) addresses, and network-layer addresses.

Data Link Layer addresses

A data-link layer address unambiguously identifies every physical network association of a network device. Data-link addresses typically area unit cited as physical or hardware addresses. Data-link addresses sometimes exist among a flat address area and have a pre-established and usually fastened relationship to a selected device. End systems usually have just one physical network association, and therefore have just one data-link address. Routers and different internetworking devices usually have multiple physical network connections and so eventually have multiple data-link addresses.

A data-link layer address uniquely identifies each physical network connection of a network device. Data-link addresses sometimes are referred to as physical or hardware addresses. Data-link addresses usually exist within a flat address space and have a pre-established and typically fixed relationship to a specific device.

End systems generally have only one physical network connection, and thus have only one data-link address. Routers and other internetworking devices typically have multiple physical network connections and therefore also have multiple data-link addresses. Figure 9.1 illustrates how each interface on a device is uniquely identified by a data-link address.

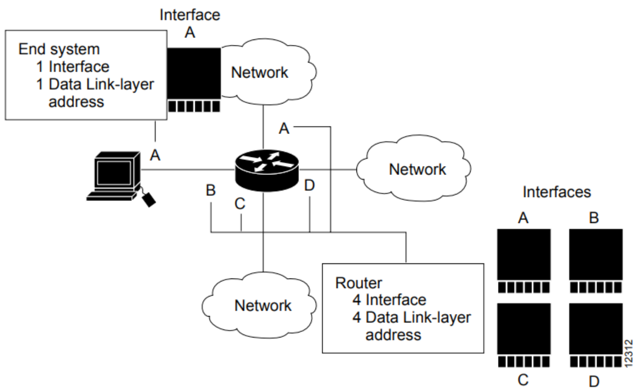


Figure 9.1: Each interface on a device is uniquely identified by a data-link address.

MAC Addresses

Media Access management (MAC) addresses encompass a set of data-link layer addresses. MAC addresses establish network entities in LANs that implement the IEEE MAC addresses of the data-link layer. MAC addresses different area unit distinctively for every local area network interface. MAC addresses are forty-eight bits long and are expressed in form of twelve hexadecimal digits. The primary half dozen hexadecimal digits that are usually administered by the IEEE establish the manufacturer or merchant and therefore comprise the Organizational Unique Identifier (OUI). The last half dozen positional notation digits comprise the interface serial variety or another price administered by the particular merchant. MAC addresses typically area unit referred to as burned-in addresses (BIAs) as a result of burned into read-only memory (ROM) and are traced into random-access memory (RAM) once the interface card initializes.

Media Access Control (MAC) addresses consist of a subset of data-link layer addresses. MAC addresses identify network entities in LANs that implement the IEEE MAC addresses of the data-link layer. As with most data-link addresses, MAC addresses are unique for each LAN interface. Figure 9.2 illustrates the relationship between MAC addresses, data-link addresses, and the IEEE sub-layers of the data-link layer.

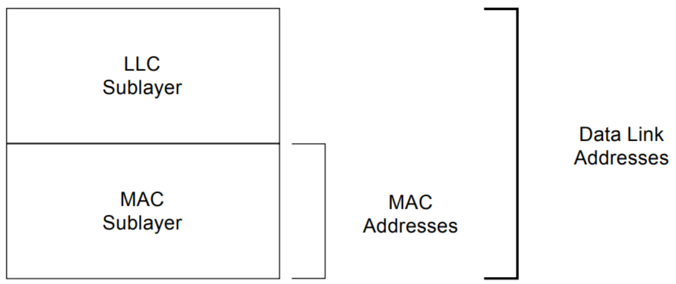


Figure 9.2: MAC addresses, data-link addresses, and the IEEE sub-layers of the data-link layer are all related.

MAC addresses are 48 bits in length and are expressed as 12 hexadecimal digits. The first 6 hexadecimal digits, which are administered by the IEEE, identify the manufacturer or vendor and thus comprise the Organizational Unique Identifier (OUI). The last 6 hexadecimal digits comprise the interface serial number, or another value administered by the specific vendor. MAC addresses sometimes are called burned-in addresses (BIAs) because they are burned into read-only memory (ROM) and are copied into random-access memory (RAM) when the interface card initializes. Figure 9.3 illustrates the MAC address format.

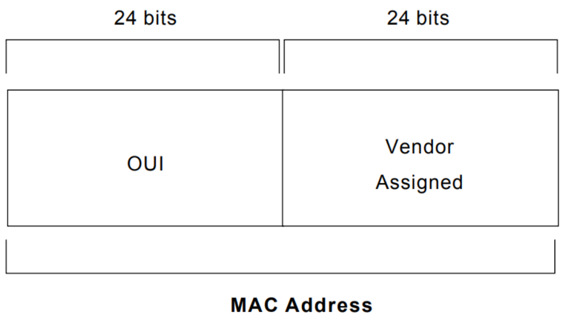


Figure 9.3: The MAC address contains a unique format of hexadecimal digits.

Different protocol suites use different methods for determining the MAC address of a device. The following three methods are used most often: Address Resolution Protocol (ARP) maps network addresses to MAC addresses. Hello protocol enables network devices to learn the MAC addresses of other network devices. MAC addresses are either embedded in the network-layer address or are generated by an algorithm.

Address resolution is the process of mapping network addresses to Media Access Control (MAC) addresses. This process is accomplished by using the Address Resolution Protocol (ARP), which is implemented by many protocol suites. When a network address is successfully associated with a MAC address, the network device stores the information in the ARP cache. The ARP cache enables devices to send traffic to a destination without creating ARP traffic because the MAC address of the destination is already known.

The process of address resolution differs slightly, depending on the network environment. Address resolution on a single LAN begins when End System A broadcasts an ARP request onto the LAN in an attempt to learn the MAC address of End System B. The broadcast is received and processed by all devices on the LAN, although only End System B replies to the ARP request by sending an ARP reply containing its MAC address to End System A. End System A receives the reply and saves the MAC address of End System B in its ARP cache. (The ARP cache is where network addresses are associated with MAC addresses.)Whenever End System A must communicate with End System B, it checks the ARP cache, finds the MAC address of System B, and sends the frame directly without first having to use an ARP request.

Address resolution works differently, however, when source and destination devices are attached to different LANs that are interconnected by a router. End System Y broadcasts an ARP request onto the LAN in an attempt to learn the MAC address of End System Z. The broadcast is received and processed by all devices on the LAN, including Router X, which acts as a proxy for End System Z by checking its routing table to determine that End System Z is located on a different LAN. Router X then replies to the ARP request from End System Y, sending an ARP reply containing its own MAC address as if it belonged to End System Z. End System Y receives the ARP reply and saves the MAC address of Router X in its ARP cache in the entry for End System Z. When End System Y must communicate with End System Z, it checks the ARP cache, finds the MAC address of Router X, and sends the frame directly without using ARP requests. Router X receives the traffic from End System Y and forwards it to End System Z on the other LAN.

The Hello protocol is a network-layer protocol that enables network devices to identify one another and indicate that they are still functional. When a new end system powers up, for example, it broadcasts Hello messages onto the network. Devices on the network then return Hello replies, and Hello messages are also sent at specific intervals to indicate that they are still functional. Network devices can learn the MAC addresses of other devices by examining Hello-protocol packets.

Three protocols use predictable MAC addresses. In these protocol suites, MAC addresses are predictable because the network layer either embeds the MAC address in the network-layer address or uses an algorithm to determine the MAC address. The three protocols are Xerox Network Systems (XNS), Novell Internetwork Packet Exchange (IPX), and DECnet Phase IV.

Network-Layer Addresses

Network addresses sometimes exist among a gradable address area and typically area unit referred to as virtual or logical addresses. The connection between a network address and a tool is logical and unfixed, it usually relies either on physical network characteristics or on groupings that don't have any physical basis. Finish systems need one network-layer address for every network-layer protocol they support. Routers and different Internetworking devices need one network-layer address per physical network association for every network-layer protocol supported.

The relationship between a network address and a device is logical and unfixed; it typically is based either on physical network characteristics (the device is on a particular network segment) or on groupings that have no physical basis (the device is part of an AppleTalk zone). End systems require one network-layer address for each network-layer protocol they support. (This assumes that the device has only one physical network connection.) Routers and other internetworking devices require one network-layer address per physical network connection for each network-layer protocol supported. A router, for example, with three interfaces each running AppleTalk, TCP/IP, and OSI must have three network-layer addresses for each interface. The router therefore has nine network-layer addresses. Figure 9.4 illustrates how each network interface must be assigned a network address for each protocol supported.

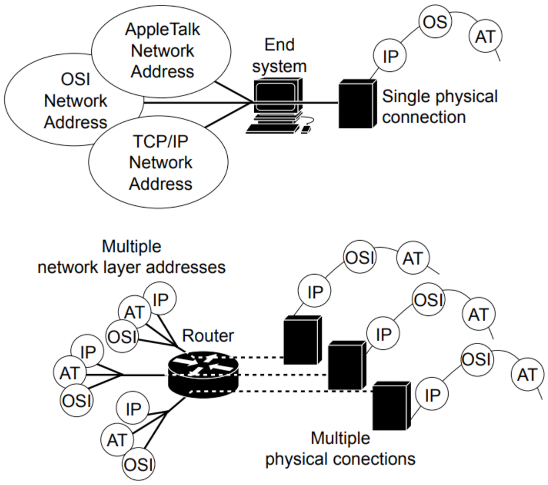


Figure 9.4: Each network interface must be assigned a network address for each protocol supported.

REMEMBER

A network-layer address identifies an entity at the network layer of the OSI layers. Network addresses usually exist within a hierarchical address space and sometimes are called virtual or logical addresses.

9.1.4 Unit of Internetworking

Internetworking is "the concept of interconnecting different types of networks to build a large, global network" such that any pair of connected hosts can exchange packets. To build an internetwork, the following are needed: A standardized scheme to address packets to any host on any participating network; a standardized protocol defining format and handling of transmitted packets; components interconnecting the participating networks by routing packets to their destinations based on standardized addresses.

There are chiefly 3 unit of Internetworking

- Extranet
- Intranet
- Internet

Intranets and extranets might or might not have connections to the net. If there is a connection to the net, the computer network or extranet area unit is usually shielded from being accessed from the net if it is not authorized.

The net isn't thought-about to be a section of the computer network or extranet, though it should function a portal for access to parts of associate degree extranet.

- **Extranet –** It's a network of the internetwork that's restricted in scope to one organization or entity however that additionally has restricted connections to the networks of one or a lot of different sometimes, however not essential. It's very lowest level of Internetworking, usually enforced in an exceedingly personal area. Associate degree extranet may additionally be classified as a Man, WAN, or different form of network however it cannot encompass one local area network i.e. it should have a minimum of one reference to associate degree external network.
- **Intranet –** This associate degree computer network could be a set of interconnected networks, which exploits the Internet Protocol and uses IP-based tools akin to web browsers and FTP tools, that's underneath the management of one body entity. That body entity closes the computer network to the remainder of the planet and permits solely specific users. Most typically, this network is the internal network of a corporation or different enterprise. An outsized computer network can usually have its own internet server to supply users with browseable data.
- **Internet –** A selected Internetworking, consisting of a worldwide interconnection of governmental, academic, public, and personal networks based mostly upon the Advanced analysis comes Agency Network (ARPANET) developed by ARPA of the U.S. Department of Defense additionally home to the World Wide Web (WWW) and cited as the 'Internet' to differentiate from all different generic Internetworks. Participants within the web, or their service suppliers, use IP Addresses obtained from address registries that management assignments.

Internetworking has evolved as an answer to a few key problems: isolated LANs, duplication of resources, and an absence of network management. Isolated LANs created transmission problem between totally different offices or departments. Duplication of resources meant that constant hardware and code had to be provided to every workplace or department, as did a separate support employee. This lack of network management meant that no centralized methodology of managing and troubleshooting networks existed.

One more form of interconnection of networks usually happens among enterprises at the Link Layer of the networking model, i.e. at the hardware-centric layer below the amount of the TCP/IP logical interfaces. Such interconnection is accomplished through network bridges and network switches. This can be typically incorrectly termed internetworking, however, the ensuing system is just a bigger, single sub-network, and no internetworking protocol, akin to web Protocol, is needed to traverse these devices.

However, one electronic network is also reborn into associate degree internetwork by dividing the network into phases and logically dividing the segment traffic with routers. The Internet Protocol is meant to supply an associate degree unreliable packet service across the network. The design avoids intermediate network components maintaining any state of the network. Instead, this task is allotted to the endpoints of every communication session. To transfer information correctly, applications should utilize associate degree applicable Transport Layer protocol, akin to Transmission management Protocol (TCP) that provides a reliable stream. Some applications use a less complicated, connection-less transport protocol, User Datagram Protocol (UDP), for tasks that don't need reliable delivery of information or that need period of time service, akin to video streaming or voice chat.

9.2 INTERNETWORK ARCHITECTURE

An internetwork is a collection of packet-switching and broadcast networks, connected by bridges, switches, or routers which are intermediate networking devices, that functions as a single large network. So all users and devices can communicate, regardless of the network segment to which they are attached. Figure 9.5 illustrates some different kinds of network technologies that can be interconnected by routers and other networking devices to create an internetwork.

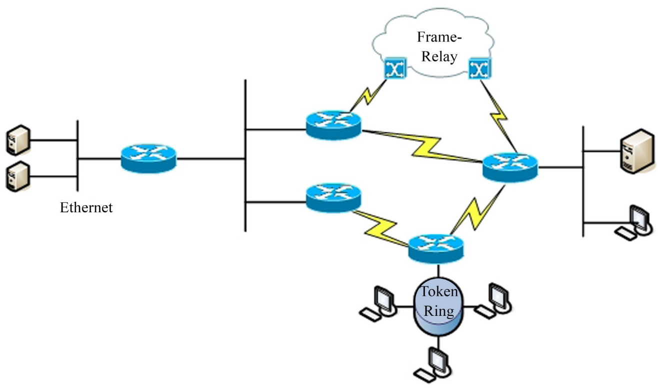


Figure 9.5: Internetworking

The different kinds of networks that join together to form an Internetwork can be categorized as Local Area Networks (LANs) and Wide Area Networks (WANs)

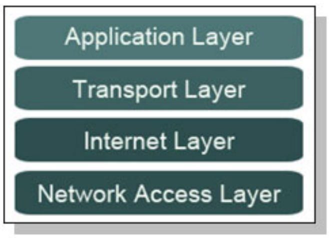
Local Area Network (LAN) is a network that is limited to small geographical area, such as an office building or even a network of computers and devices in a home. A Local Area Network (LAN) is used for many purposes like sharing of resources, gaming and collaboration. In a Local Area Network the complete infrastructure of the network is owned by the company itself that includes devices like switches and cables. A Local Area network provides high-speed connectivity ranging from 10 Mbps to 10 Gbps but the media suffers from distance limitation.

Wide Area Networks (WAN) cover a broad geographic area such as cities, country or even across continents. Wide Area Networks are used to interconnect multiple Local Area Networks that are several miles apart. Due to the long distance connectivity an organization has to purchase WAN service from a service provider or a carrier. There are several types of Wide Area Networks such as leased lines, circuit-switched networks and packet-switched networks.

A company or an organization that has to connect multiple offices that span over cities, countries or even the entire globe subscribe to WAN service from a provider, whereas Local Area Networks are owned by the organization itself and there is no need to purchase any kind of connectivity service.

The Internet Protocol Suite commonly known as the TCP/IP Protocol Stack is a standard set of communication protocols developed as a result of research and development conducted by the DARPA for the ARPANET. This protocol suite was developed so that a standard means of communications can be achieved which would allow different types of networks having different computer systems to communicate with each other. The Internet Protocol Suite is framework that defines a set of general design guidelines and implementations of specific networking protocols to enable computers to communicate over a network. RFC 1122 describes the Internet Protocol Suite architectural model which commonly is referred as the TCP/IP Model. To communicate using the over the Internet, a host must implement the layered set of protocols comprising the Internet protocol suite.

Figure below shows the TCP/IP model that comprises of four layers.



The Application Layer is the top-most layer, it refers to the higher-level protocols used by applications for network communication such as File Transfer Protocol (FTP), Hyper Text Transfer Protocol (HTTP) and Simple Mail Transfer Protocol (SMTP).

The transport layer provides end-to-end communication services for applications. There are two primary transport layer protocols

- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)

TCP is a reliable connection-oriented transport service that provides end-to-end reliability, re-sequencing, and flow control. While UDP is a connectionless ("datagram") transport service.

The Internet Layer describes a group of methods, protocols, and specifications which are used to transport datagrams (packets) from a host across network boundaries, if necessary, to the destination host specified by a network address (IP address) which is defined for this purpose by the Internet Protocol (IP). Every machine on the Internet whether it is a host machine accessing services or a server providing services needs a unique IP address which identifies that system on the Internet. IP version 4 (IPv4) is the current version of Internet Protocol being used on the Internet. IPv4 defines a 32-bit address which allows the possibility of 4,294,967,296 unique addresses, however due to the rapid growth of the Internet this space is limited. IP version 6 (IPv6) which is intended to be the successor of IPv4 has a 128-bit address space which vastly larger than IPv4 address space.

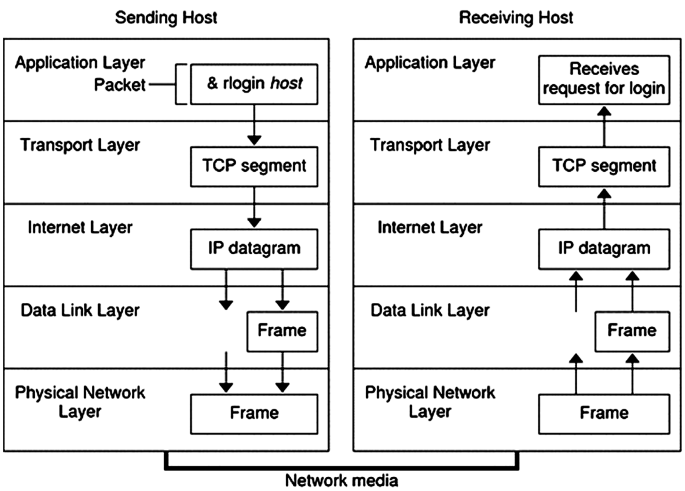
All Internet transport protocols use the Internet Protocol (IP) to carry data from source host to destination host. IP is a connectionless or datagram internetwork service, providing no end-to-end delivery guarantees.

The Network Access Layer also known as the Link Layer or the Media Access Layer defines protocols and specifications that must be implemented by the host to communicate with its directly connected network.

How the TCP/IP Protocols Handle Data Communications

When a user issues a command that uses a TCP/IP application layer protocol, a series of events is initiated. The user's command or message passes through the TCP/IP protocol stack on the local system. Then, the command or message passes across the network media to the protocols on the remote system. The protocols at each layer on the sending host add information to the original data. Protocols on each layer of the sending host also interact with their peers on the receiving host.

Figure below shows how two hosts communicate using the TCP/IP protocol stack.



The Internet is the most notable example of an Internetwork. Internet is the global network formed by connecting several computer networks across the globe. The individual private and public networks of different sizes and categories, used for different purposes and utilizing a broad array of technologies interconnect together to form the internet. The origins of the Internet date back to 1960s when Defense Advanced Research Projects Agency (DARPA) of the United States developed the ARPANET which is known as the predecessor of the Internet. The ARPANET which was research government military project become commercialized in the 1980s and within a couple of years a rapid expansion and interconnection of several different computer networks led to the Internet.

Key Internet Services, and technologies and protocols that enable these services

Today the Internet has become a globally distributed network that can be accessed from anywhere by numerous means. Over the years the Internet has evolved from a defense research project to global network used for various purposes such as business/ corporate communications, social networking and multimedia.

The Internet offers various services using different technologies and protocols some of which are discussed below

World Wide Web: World Wide Web (WWW) is a system of interlinked hypertext documents contained on the Internet. With a web browser, one can view web pages that may contain text, images, videos, and other multimedia and navigate between them by using hyperlinks. Today there are millions of websites on the Internet that provide different types of content, this services is one of the biggest selling points for the Internet. The entire web is supported by the Hyper Text Transfer Protocol (HTTP), an application layer protocol used by web browsers that act as HTTP client's requests information from Web Servers that host websites. A **Uniform Resource Locator (URL)** is used to identify a Web Site address, HTTP is used to request resources/information from web servers using URLs.

Keyword

Uniform Resource Locator, colloquially termed a web address, is a reference to a web resource that specifies its location on a computer network and a mechanism for retrieving it.

Email: Electronic Mail or in short e-mail is method of exchanging digital messages. Along with the World Wide Web the Email is one of the most popular service offered by the Internet. There are several standards and protocols for the Email system which allows Internet users to exchange messages over the Internet. Simple Mail Transfer Protocol (SMTP) is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks. SMTP is used by Email servers to send and receive mail messages while clients (end-users) usually use Post Office Protocol (POP) or the Internet Message Access Protocol (IMAP) to access their mail box accounts on a mail server.

Internet Infrastructure: The Internet is made of up several interconnected networks, at its very edge individual users or corporate private networks connect to the Internet via an Internet Service Provider (ISP), the ISP serves many users through various physical mediums such as Wireless Connections and DSL, these ISP in an Internet Infrastructure are known as Local ISPs. The Local ISP may peer with each other but usually they peer with a regional ISP that interconnects multiple local ISPs, the regional ISP peer with the bigger provider called the Network Service Provider (NSP). However this may not be assumed as true Internet infrastructure as a complete picture of the Internet is difficult to graph due to various peering, connections and other complexities.

9.2.1 Application Layer

The application layer provides services for an application program to ensure that effective communication with another application program on a network is possible. The application layer should not be thought of as an application as most people understand it. Instead, the application layer is a component within an application that controls the communication method to other devices. It's an abstraction layer service that masks the rest of the application from the transmission process. The application layer relies on all the layers below it to complete its process. At this stage, the data, or the application, is presented in a visual form the user can understand.

Functions of the application layer

- Ensures that the receiving device is identified, can be reached and is ready to accept data.
- Enables, if appropriate, authentication to occur between devices for an extra layer of security.
- Makes sure necessary communication interfaces exist. For example, is there an Ethernet or Wi-Fi interface in the sender's computer?
- Ensures agreement at both ends about error recovery procedures, data integrity and privacy.
- Determines protocol and data syntax rules at the application level.
- Presents the data on the receiving end to the user application.

The application layer in the OSI model is the closest layer to the end user which means that the application layer and end user can interact directly with the software application. The application layer programs are based on client and servers.

The Application layer includes the following functions:

- **Identifying communication partners:** The application layer identifies the availability of communication partners for an application with data to transmit.
- **Determining resource availability:** The application layer determines whether sufficient network resources are available for the requested communication.
- **Synchronizing communication:** All the communications occur between the applications requires cooperation which is managed by an application layer.

Services of Application Layers

- **Network Virtual terminal:** An application layer allows a user to log on to a remote host. To do so, the application creates a software emulation of a terminal at the remote host. The user's computer talks to the software terminal, which in turn, talks to the host. The remote host thinks that it is communicating with one of its own terminals, so it allows the user to log on.
- **File Transfer, Access, and Management (FTAM):** An application allows a user to access files in a remote computer, to retrieve files from a computer and to manage files in a remote computer. FTAM defines a hierarchical virtual file in terms of file structure, file attributes and the kind of operations performed on the files and their attributes.
- **Addressing:** To obtain communication between client and server, there is a need for addressing. When a client made a request to the server, the request

contains the server address and its own address. The server response to the client request, the request contains the destination address, i.e., client address. To achieve this kind of addressing, DNS is used.

- **Mail Services:** An application layer provides Email forwarding and storage.
- **Directory Services:** An application contains a distributed database that provides access for global information about various objects and services.
- Authentication: It authenticates the sender or receiver's message or both.

A computer network is typically designed based on a network diagram. This topology is defined based on the open systems interconnection model (OSI) and consists of seven layers of network functionality. The application layer is the highest level within OSI, which is known as layer seven. It is the network layer that manages communication programs on the network, including **file transfer protocol (FTP)**, hypertext transfer protocol (HTTP), and email. These programs enable Internet browsers and email applications to a share data across a network.

Keyword

File Transfer Protocol (FTP) is a standard network protocol used for the transfer of computer files between a client and server on a computer network.

A network begins with a physical cable and ends with a computer application. Data is forced through several levels of transformations during a typically communication transfer. This is a necessary process to ensure proper data quality and security rules are followed. The OSI model was created to enable flexibility in software protocols.

The OSI model is made up of seven layers. These are the physical, data link, network, transport, session, presentation, and application layers. The layers work within a hierarchal structure to send messages across a network.

Most computer networks today use standard transmission control protocol (TCP/IP) as the communication language for the Internet. This network protocol uses the OSI model as a blueprint on how network devices and software should interact. Each layer in the model has a specific responsibility within the network topology.

The OSI model is designed based on a hierarchal chaining of responsibility. These rules force each layer to follow specific handoff processes when sending a message through the topology.

The application layer is required to follow the handoff rules of the presentation layer, which is the next level within the hierarchy chain. These rules typically include format, encryption, and specific size requirements before the message can be accepted by the next level in the chain.

Instant messaging (IM) is a poplar communication protocol that is used on cell phones and computer systems. IM is an example of software that uses the application layer protocol. The IM standard protocol makes it possible for companies to build instant messaging software. Some examples of these products include AOL Instant Messenger, Yahoo mail and MSN messenger. Each program uses the OSI standards to send and receive messages across the network at this layer.

Microsoft Outlook is an example of an email application that uses the application layer. This is the lowest level of the OSI model, which is responsible for packaging messages from a software program into an understandable computer message. The application layer sends a message to the presentation layer, which is responsible for the encryption and format rules of the message.

9.2.2 Transport Layer

A transport layer is required for transporting data beyond the boundaries of an address space. From the point of view of the transport layer, the data being transported consist of unstructured byte sequences. The transport layer is implemented by a concrete transport mechanism. The task of the transport layer is to abstract from platform-specific transport mechanisms and to offer a homogeneous interface to the presentation layer. The transport layer is typically merely a wrapper of the network functions offered by an operating system. Similar to the introduction of the bank scenario, an analysis of requirements presents the characteristics of the transport layer that form the basis for a design:

1. The transport layer guarantees a reliable end-to-end connection between precisely two address spaces.
2. Data can be sent bi-directionally in the form of unstructured byte sequences of any length.
3. Different transport mechanisms should be supported.

Transport layer links address spaces

The transport layer offers reliable end-to-end connections; that is, details of the underlying transport mechanism are hidden above the transport layer. Many transport mechanisms, such as TCP, already offer reliable connections. However, implementation of the transport layer using an unreliable transport mechanism makes it more difficult to guarantee suitable semantics above the transport layer.

The requirement that the transport layer should link exactly two address spaces together is aimed at reducing the complexity of the middleware. If this restriction did not exist, the administration of the transport channels between various address spaces would be complex. As a consequence, μORB only permits the objects belonging to an application to be distributed among exactly two address spaces.

The transport layer views data that are exchanged between a client and a server over the transport layer as unstructured, variable-length byte sequences. However, the transport layer is not expected to transmit continuous media, a capability required by multimedia applications. On the other hand, the assumption is that it will support different transport mechanisms.

The following use case suggests the type of modeling required at the class level:

1. The server establishes a communication end point and waits for a connection setup request.
2. The client creates a communication end point and connects it to the server.
3. The client sends data and waits for a response.
4. The server receives the data of the client and then sends a response.
5. After the client receives the response from the server, both close their communication end points

Applications scenario of the transport layer

Note that in this use case the words "client" and "server" do not refer to objects. They refer instead to roles taken in interaction with the transport layer, thus indicating an asymmetry in the use of the transport layer. Clients and servers define a communications channel on the basis of the corresponding communication end points. The communication end points are specified by an address that represents a mutual consent between client and server. An address of the transport layer typically contains a network address that refers to the actual transport mechanism. Different transport mechanisms can have different address formats and details. Thus a generally valid format does not exist.

Classes Buffer, Address, and Transport model transport layer

Three classes are introduced for modeling the transport layer: Buffer, Address, and Transport. The class Buffer represents the storage area associated with a chunk of memory. Instances of this class are used as containers for the unstructured byte sequences that are transmitted between address spaces via a transport mechanism. The interface of the class Buffer offers methods for setting up and managing a memory chunk.

The class Address represents the address of a particular transport mechanism, and the class Transport represents the transport mechanism itself. The address here is used as a *factory* for the transport mechanism. The two classes themselves are abstract because they only form the interface for the actual transport mechanism. Therefore, two concrete classes have to be defined for each transport mechanism: one for the address and one for the transport mechanism itself. These classes are derived from the abstract base classes Address and Transport. Figure 9.6 shows a TCP-based transport mechanism in UML notation.

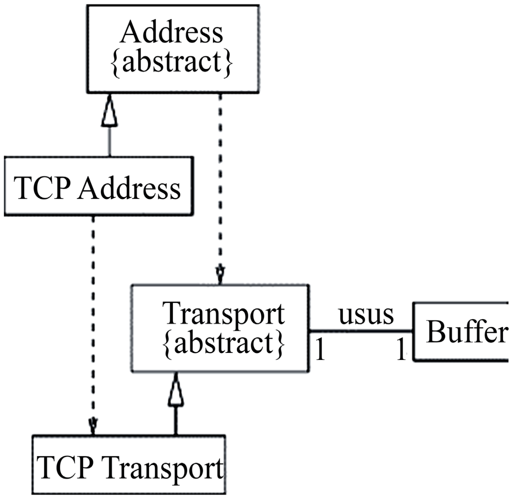


Figure 9.6: UML class diagram of transport layer.

Keyword

User Datagram Protocol (UDP) is an alternative communications protocol to TCP used primarily for establishing low-latency and loss-tolerating connections between applications on the internet.

Responsibilities of a Transport Layer

Transport Layer is the second layer of the TCP/IP model. It is an end-to-end layer used to deliver messages to a host. It is termed as an end-to-end layer because it provides a point-to-point connection rather than hop-to- hop, between the source host and destination host to deliver the services reliably. The unit of data encapsulation in Transport Layer is a segment.

The standard protocols used by Transport Layer to enhance its functionalities are TCP (Transmission Control Protocol), **UDP (User Datagram Protocol)**, DCCP (Datagram Congestion Control Protocol) etc.

Various responsibilities of a Transport Layer –

- **Process to process delivery –**While Data Link Layer requires the MAC address (48 bits address contained inside the Network Interface Card of every host machine) of source-destination hosts to correctly deliver a frame and Network layer requires the IP address for appropriate routing of packets, in a similar way Transport Layer requires a Port number to correctly deliver the segments of data to the correct process amongst the multiple processes running on a particular host. A **port number** is a 16 bit address used to identify any client-server program uniquely.
- **End-to-end Connection between hosts –**The transport layer is also responsible for creating the end-to-end Connection between hosts for which it mainly uses TCP and UDP. TCP is a secure, connection- orientated protocol which uses a handshake protocol to establish a robust connection between two end- hosts. TCP ensures reliable delivery of messages and is used in various applications. UDP, on the other hand, is a stateless and unreliable protocol which ensures best-effort delivery. It is suitable for the applications which have little concern with flow or error control and requires to send the bulk of data like video conferencing. It is often used in multicasting protocols.
- **Multiplexing and Demultiplexing –**Multiplexing allows simultaneous use of different applications over a network which is running on a host. The transport layer provides this mechanism which enables us to send packet streams from various applications simultaneously over a network. The transport layer accepts these packets from different processes differentiated by their port numbers and passes them to the network layer after adding proper headers. Similarly, Demultiplexing is required at the receiver side to obtain the data coming from various processes. Transport receives the segments of data from the network layer and delivers it to the appropriate process running on the receiver's machine.
- **Congestion Control –**Congestion is a situation in which too many sources over a network attempt to send data and the router buffers start overflowing due to which loss of packets occur. As a result retransmission of packets from the sources increases the congestion further. In this situation, the Transport layer provides Congestion Control in different ways. It uses open loop congestion control to prevent the congestion and closed loop congestion control to remove the congestion in a network once it occurred. TCP provides AIMD- additive increase multiplicative decrease, leaky bucket technique for congestion control.
- **Data integrity and Error correction –**Transport layer checks for errors in the messages coming from application layer by using error detection codes, computing checksums, it checks whether the received data is not corrupted and uses the ACK and NACK services to inform the sender if the data has

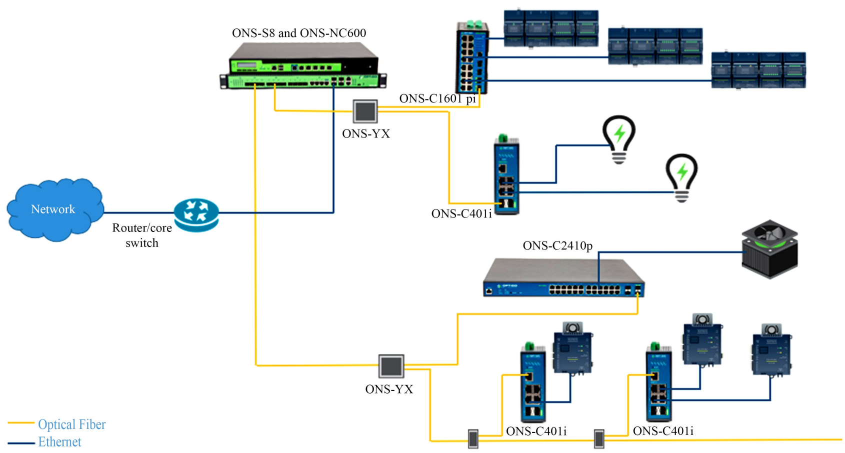
arrived or not and checks for the integrity of data.

- **Flow control –**The transport layer provides a flow control mechanism between the adjacent layers of the TCP/IP model. TCP also prevents data loss due to a fast sender and slow receiver by imposing some flow control techniques. It uses the method of sliding window protocol which is accomplished by the receiver by sending a window back to the sender informing the size of data it can receive.

9.2.3 Internet Layer

The Internet layer is responsible for placing data that needs to be transmitted into data packets known as IP datagrams. These will contain the source and destination addresses for the data within.

This layer is also responsible for routing the IP datagrams. The main protocols included at the Internet layer are Internet Protocol (IP), Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), and Internet Group Management Protocol (IGMP).



Static IP

Static IP (also known as fixed IP address – view from 10:20 to 13:20) is a manually configured IP address for a device. The IP address is referred to as static because it does not change without user input. When setting up a controller, you will manually assign an IP address that corresponds to the IP range chosen for the job or assigned by the IT department. Each device on the network must have a unique IP address and each device will have to be manually assigned.

The major disadvantage that static IP addresses have over dynamic addresses is that you have to configure the devices manually. Typically this is done on a per-device basis.

DHCP

Dynamic Host Configuration Protocol is a client/server protocol that automatically provides an IP host with its IP address and other related configuration information, like the subnet mask and default gateway.

DHCP provides an automated way to distribute and update IP addresses and other configuration information on a network. Typically, a DHCP server will respond to requests from clients with an address that resides in the DHCP scope. Along with IP addresses, DHCP servers can provide other information concerning the network if they are configured to do so.

A DHCP scope is a valid range of IP addresses that are available for assignment or lease to client computers on a particular subnet. In a DHCP server, a scope is configured to determine the address pool of IPs that the server can provide to DHCP clients.

When an address has a dynamic lease, the DHCP server can manage the address by allocating it to a client, extending the lease time, detecting when it is no longer in use, and reclaiming it.

Conversely, a DHCP reservation is a permanent IP address assignment. It is a specific IP address within a DHCP scope that is permanently reserved for leased use to a specific DHCP client.

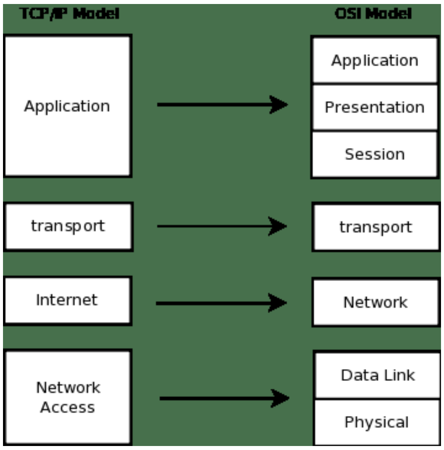
Lease reservations are preferred over dynamic leases in controls networks. Knowing the IP address of a controller can be critical to sending and receiving data to other devices in the same network. Ensuring that the IP address doesn't change will make the system easier to configure and manage. To make use of lease reservations, you will need to know the MAC address for the controller. You will need to provide this to whoever is managing the DHCP server so they can ensure each controller gets the IP address it's supposed to have.

9.2.4 Network Access Layer

The Network Access layer of the TCP/IP model corresponds with the Data Link and Physical layers of the OSI reference model. It defines the protocols and hardware required to connect a host to a physical network and to deliver data across it. Packets from the Internet layer are sent down the Network Access layer for delivery within the physical network. The destination can be another host in the network, itself, or a router for further forwarding. So the Internet layer has a view of the entire Internetwork whereas the Network Access layer is limited to the physical layer boundary that is often defined by a layer 3 device such as a router.

Network Access layer uses a physical address to identify hosts and to deliver data.

- The Network Access layer PDU is called a frame. It contains the IP packet as well as a protocol header and trailer from this layer.
- The Network Access layer header and trailer are only relevant in the physical network. When a router receives a frame, it strips of the header and trailer and adds a new header and trailer before sending it out the next physical network towards the destination.



REMEMBER

The Network Access layer consists of a large number of protocols. When the physical network is a LAN, Ethernet at its many variations are the most common protocols used. On the other hand when the physical network is a WAN, protocols such as the Point-to-Point Protocol (PPP) and Frame Relay are common.

The Network Access layer is the lowest level of the TCP/IP protocol hierarchy. It is often ignored by users as it is well hidden by the better known mid-level protocols such as IP, TCP, and UDP, and higher level protocols such as SMTP, HTTP, and FTP. Functions performed at the network access layer include encapsulation of IP datagrams into frames to be transmitted by the network, and mapping IP addresses to physical hardware addresses.

Much of the work that takes place at the network access layer is handled by software applications and drivers that are unique to individual pieces of hardware. Configuration often consists of simply selecting the appropriate driver for loading, and selecting TCP/IP as the protocol for use. Many computers come with this driver software pre-loaded and configured, or can automatically configure themselves via "plug-and-play" applications.

A good example of configuration at the network access layer would be setting up a Windows NT system to use a 3-Com Etherlink III **network interface card (NIC)** with Ethernet. Under normal circumstances the NIC would be detected by the operating system at installation time. If this does not occur, or if the card is added at a later time, the installation procedure would consist mostly of installing the card and selecting the driver by choosing the manufacturer and model of the card from a list of available drivers. Some cards might additionally require minimal hardware configuration, such as selecting an I/O port, IRQ setting, and possibly whether to use the Twisted Pair or Co-Ax connector on the card. Once the correct driver is selected for the card and configured, the next step is to select TCP/IP from a list of available protocols to be used on the interface. Once this is done, the network access layer configuration is complete. Many configuration programs automatically move on to configuring the IP address, netmask, DNS servers, default gateways, and other parameters which actually relate to other layers and protocols.

Keyword

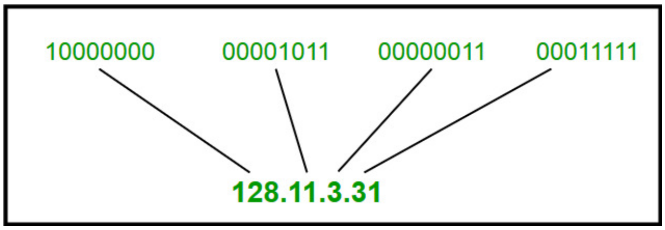
Network interface card (NIC) is a hardware component without which a computer cannot be connected over a network.

Some network access layer protocols do require extensive configuration. It is good to have an understanding of the more common of these and how they work. If a network manager will be dealing with remote access across serial communications lines, using POTS modems or ISDN lines for example, it is important to be familiar with serial point-to-point protocols such as SLIP and PPP. If these will be used on Network Access Server equipment, like modem stacks or terminal servers, it is valuable to be familiar with remote authentication protocols such as TACACS and RADIUS.

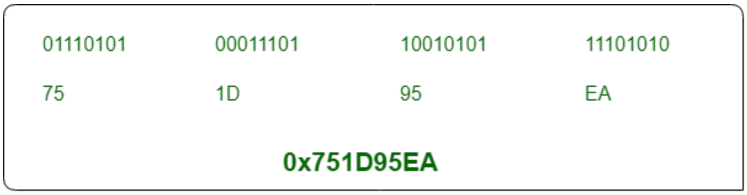
9.3 IP ADDRESSING AND ARCHITECTURE

IP address is an address having information about how to reach a specific host, especially outside the LAN. An IP address is a 32 bit unique address having an address space of 2^{32}. Generally, there are two notations in which IP address is written, dotted decimal notation and hexadecimal notation.

Dotted Decimal Notation:



Hexadecimal Notation:



Some points to be noted about dotted decimal notation:

- The value of any segment (byte) is between 0 and 255 (both included).
- There are no zeroes preceding the value in any segment (054 is wrong, 54 is correct).

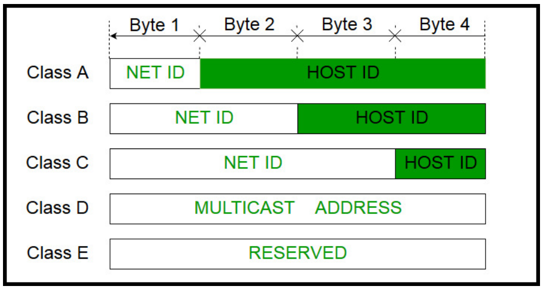
Classful Addressing. The 32 bit IP address is divided into five sub-classes. These are:

- Class A
- Class B
- Class C
- Class D
- Class E

Each of these classes has a valid range of IP addresses. Classes D and E are reserved for multicast and experimental purposes respectively. The order of bits in the first octet determine the classes of IP address. IPv4 address is divided into two parts:

- Network ID
- Host ID

The class of IP address is used to determine the bits used for network ID and host ID and the number of total networks and hosts possible in that particular class. Each ISP or network administrator assigns IP address to each device that is connected to its network.



Keyword

Regional Internet registry (RIR) is an organization that manages the allocation and registration of Internet number resources within a region of the world.

IP addresses are globally managed by Internet Assigned Numbers Authority (IANA) and **regional Internet registries (RIR).**

While finding the total number of host IP addresses, 2 IP addresses are not counted and are therefore, decreased from the total count because the first IP address of any network is the network number and whereas the last IP address is reserved for broadcast IP.

Class A:

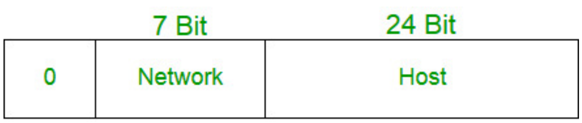
IP address belonging to class A are assigned to the networks that contain a large number of hosts.

- The network ID is 8 bits long.
- The host ID is 24 bits long.

The higher order bit of the first octet in class A is always set to 0. The remaining 7 bits in first octet are used to determine network ID. The 24 bits of host ID are used to determine the host in any network. The default subnet mask for class A is 255.x.x.x. Therefore, class A has a total of:

- 2^7-2= 126 network ID(Here 2 address is subracted because 0.0.0.0 and 127.x.y.z are special address.)
- 2^24 – 2 = 16,777,214 host ID

IP addresses belonging to class A ranges from 1.x.x.x – 126.x.x.x



Class A

Class B:

IP address belonging to class B are assigned to the networks that ranges from medium-sized to large-sized networks.

- The network ID is 16 bits long.
- The host ID is 16 bits long.

The higher order bits of the first octet of IP addresses of class B are always set to 10. The remaining 14 bits are used to determine network ID. The 16 bits of host ID is used to determine the host in any network. The default sub-net mask for class B is 255.255.x.x. Class B has a total of:

- 2^14 = 16384 network address
- 2^16 – 2 = 65534 host address

IP addresses belonging to class B ranges from 128.0.x.x – 191.255.x.x.

Class B

Class C:

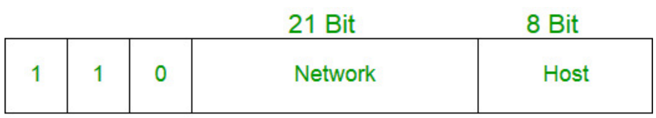
IP address belonging to class C are assigned to small-sized networks.

- The network ID is 24 bits long.
- The host ID is 8 bits long.

The higher order bits of the first octet of IP addresses of class C are always set to 110. The remaining 21 bits are used to determine network ID. The 8 bits of host ID is used to determine the host in any network. The default sub-net mask for class C is 255.255.255.x. Class C has a total of:

- 2^21 = 2097152 network address
- 2^8 – 2 = 254 host address

IP addresses belonging to class C ranges from 192.0.0.x – 223.255.255.x.

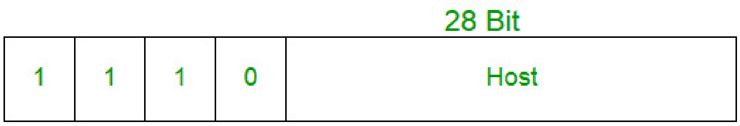


Class C

Class D:

IP address belonging to class D are reserved for multi-casting. The higher order bits of the first octet of IP addresses belonging to class D are always set to 1110. The remaining bits are for the address that interested hosts recognize.

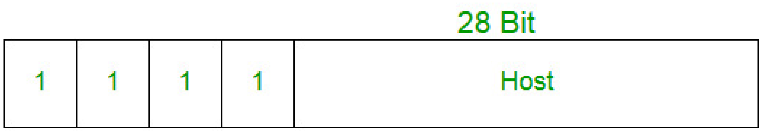
Class D does not posses any sub-net mask. IP addresses belonging to class D ranges from 224.0.0.0 – 239.255.255.255.



Class D

Class E:

IP addresses belonging to class E are reserved for experimental and research purposes. IP addresses of class E ranges from 240.0.0.0 – 255.255.255.254. This class doesn't have any sub-net mask. The higher order bits of first octet of class E are always set to 1111.



Class E

Range of special IP addresses:

169.254.0.0 – 169.254.0.16: Link local addresses

127.0.0.0 – 127.0.0.8: Loop-back addresses

0.0.0.0 – 0.0.0.8: used to communicate within the current network.

Rules for assigning Host ID: Host ID's are used to identify a host within a network. The host ID are assigned based on the following rules:

- Within any network, the host ID must be unique to that network.
- Host ID in which all bits are set to 0 cannot be assigned because this host ID is used to represent the network ID of the IP address.
- Host ID in which all bits are set to 1 cannot be assigned because this host ID is reserved as a broadcast address to send packets to all the hosts present on that particular network.

Rules for assigning Network ID: Hosts that are located on the same physical network are identified by the network ID, as all host on the same physical network is assigned the same network ID. The network ID is assigned based on the following rules:

- The network ID cannot start with 127 because 127 belongs to class A address and is reserved for internal loop-back functions.
- All bits of network ID set to 1 are reserved for use as an IP broadcast address and therefore, cannot be used.
- All bits of network ID set to 0 are used to denote a specific host on the local network and are not routed and therefore, aren't used.

9.3.1 IP Addresses Work

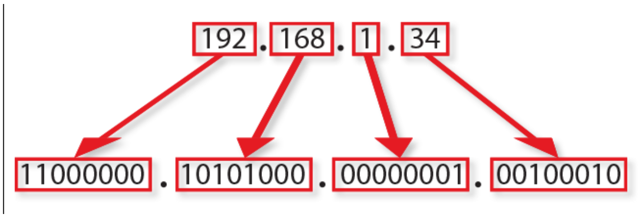
Every device connected to a network—computer, tablet, camera, whatever—needs a unique identifier so that other devices know how to reach it. In the world of TCP/IP networking, that identifier is the Internet Protocol (IP) address.

If you've worked with computers for any amount of time, you've likely been exposed to IP addresses—those numerical sequences that look something like 192.168.0.15. Most of the time, we don't have to deal with them directly, since our devices and networks take care of that stuff behind the scenes. When we do have to deal with them, we often just follow instructions about what numbers to put where.

An IP address uniquely identifies a device on a network. You've seen these addresses before; they look something like 192.168.1.34.

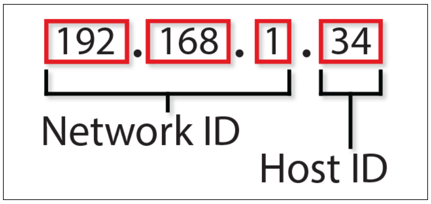
An IP address is always a set of four numbers like that. Each number can range from 0 to 255. So, the full IP addressing range goes from 0.0.0.0 to 255.255.255.255.

The reason each number can only reach up to 255 is that each of the numbers is really an eight digit binary number (sometimes called an octet). In an octet, the number zero would be 00000000, while the number 255 would be 11111111, the maximum number the octet can reach.



Computers work with the binary format, but we humans find it much easier to work with the decimal format. Still, knowing that the addresses are actually binary numbers will help us understand why some things surrounding IP addresses work the way they do.

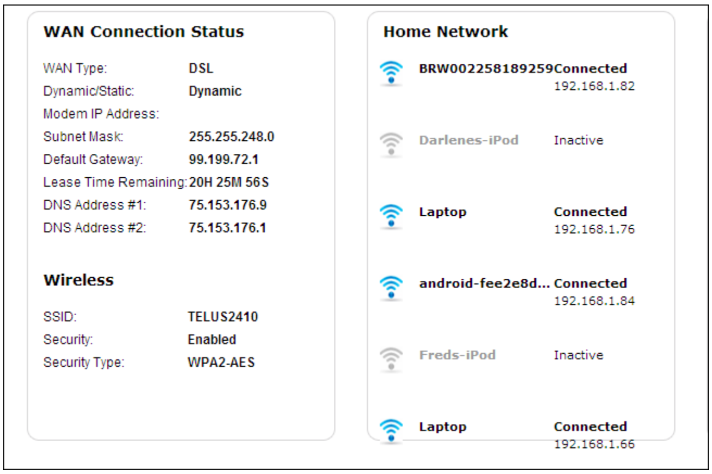
The Two Parts of an IP Address



A device's IP address actually consists of two separate parts:

- **Network ID:** The network ID is a part of the IP address starting from the left that identifies the specific network on which the device is located. On a typical home network, where a device has the IP address 192.168.1.34, the 192.168.1 part of the address will be the network ID. It's custom to fill in the missing final part with a zero, so we might say that the network ID of the device is 192.168.1.0.
- **Host ID:** The host ID is the part of the IP address not taken up by the network ID. It identifies a specific device (in the TCP/IP world, we call devices "hosts") on that network. Continuing the example of the IP address 192.168.1.34, the host ID would be 34—the host's unique ID on the 192.168.1.0 network.

On your home network, then, you might see several devices with IP address like 192.168.1.1, 192.168.1.2, 192.168.1 30, and 192.168.1.34. All of these are unique devices (with host IDs 1, 2, 30, and 34 in this case) on the same network (with the network ID 192.168.1.0).

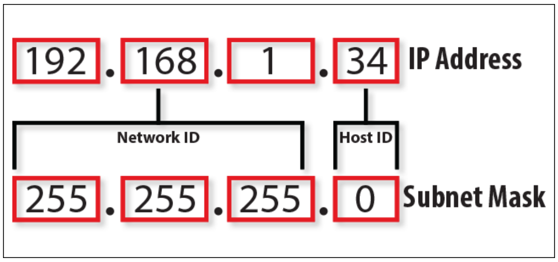


To picture all this a little better, let's turn to an analogy. It's pretty similar to how street addresses work within a city. Take an address like 2013 Paradise Street. The street name is like the network ID, and the house number is like the host ID. Within a city, no two streets will be named the same, just like no two network IDs on the same network will be named the same. On a particular street, every house number is unique, just like all host iDs within a particular network ID are unique.

The Subnet Mask

So, how does your device determine which part of the IP address is the network ID and which part the host ID? For that, they use a second number that you'll always see in association with an IP address. That number is called the subnet mask.

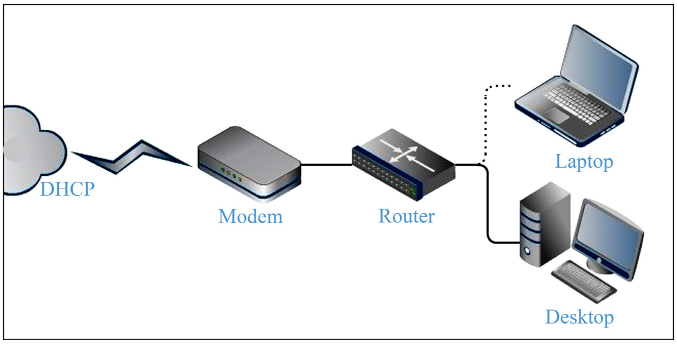
On most simple networks (like the ones in homes or small businesses), you'll see subnet masks like 255.255.255.0, where all four numbers are either 255 or 0. The position of the changes from 255 to 0 indicate the division between the network and host ID. The 255s "mask out" the network ID from the equation.



In addition to the IP address itself and the associated subnet mask, you'll also see a default gateway address listed along with IP addressing information. Depending on the platform you're using, this address might be called something different. It's sometimes called the "router," "router address," default route," or just "gateway." These are all the same thing. It's the default IP address to which a device sends network data when that data is intended to go to a different network (one with a different network ID) than the one the device is on.

The simplest example of this is found in a typical home network.

If you have a home network with multiple devices, you likely have a router that's connected to the internet through a modem. That router might be a separate device, or it might be part of a modem/router combo unit supplied by your internet provider. The router sits between the computers and devices on your network and the more public-facing devices on the internet, passing (or routing) traffic back and forth.



Say you fire up your browser and head to www.howtogeek.com. Your computer sends a request to our site's IP address. Since our servers are on the internet rather than on your home network, that traffic is sent from your PC to your router (the gateway), and your router forwards the request on to our server. The server sends the right information back to your **router**, which then routes the information back to the device that requested it, and you see our site pop up in your browser.

Keyword

Router is a networking device that forwards data packets between computer networks.

Typically, routers are configured by default to have their private IP address (their address on the local network) as the first host ID. So, for example, on a home network that uses 192.168.1.0 for a network ID, the router is usually going to be 192.168.1.1. Of course, like most things, you can configure that to be something different if you want.

DNS Servers

There's one final piece of information you'll see assigned alongside a device's IP address, subnet mask, and default gateway address: the addresses of one or two default Domain Name System (DNS) servers. We humans work much better with names than numerical addresses. Typing www.howtogeek.com into your browser's address bar is much easier than remembering and typing our site's IP address.

DNS works kind of like a phone book, looking up human-readable things like website names, and converting those to IP addresses. DNS does this by storing all that information on a system of linked DNS servers across the internet. Your devices need to know the addresses of DNS servers to which to send their queries.

On a typical small or home network, the DNS server IP addresses are often the same as the default gateway address. Devices send their DNS queries to your router, which then forwards the requests on to whatever DNS servers the router is configured to use. By default, these are usually whatever DNS servers your ISP provides, but you can change those to use different DNS servers if you want.

9.3.2 Static IP Address

Computers that connect to the Internet are assigned a unique numerical address known as an Internet Protocol (IP) address. This unique address identifies each computer on the Internet so that computers can communicate with each other by sending and receiving information using this addressing scheme. A static IP address is simply a "permanent" address that remains associated with a single computer over an extended period of time. This differs from a dynamic IP address, which is assigned ad hoc at the start of each session, normally changing from one session to the next.

IP address assignment is handled by a person's Internet Service Provider (ISP). Every ISP is designated a large block of IP addresses that fall within a specific numerical range. The ISP server automatically delegates available IP addresses within that range as needed, to clients logging on to the Internet. When a person disables his or her Internet connection, the temporarily assigned dynamic IP address goes back into the pool for reassignment. Dynamically assigned IP addresses are fine for most people, however, some prefer a static IP address.

In some situations having a static IP address is an advantage. For example, people who game online with remote players often prefer this type of IP address. When they return to a game, the hosting server recognizes them, restoring score, placement in the game, and other settings accordingly. A static IP is more reliable than a computer cookie that can be deleted.

Each website also has a static IP address, also known as a URL or Uniform Resource Locator. Without a static address, a website would not have a permanent place of residence, forcing surfers to "follow it" around the Internet, rendering bookmarks useless. This brings up the most common reason a person opts for this type of IP address: to host his or her own website.

With 24/7 broadband access and a static IP, one can create a website and act as the server, hosting it on the Internet like any other website. A static IP also allows the owner to host an email server and run other services like webcasts or forums. While these services are all available from third parties, some people prefer to act as host.

A static IP is also preferred if the computer will be connecting to a Virtual Private Network (VPN), or allowing remote access with software like pcAnywhere™ or Radmin™. Software that provides remote access need only be configured once if the remote computer in question has a static IP. If it has a changing address, the user will have to determine the remote IP each time, then reconfigure the software with the new address.

ISPs automatically assign a dynamic IP to clients unless they specifically request a static IP address. Static IP addressing is normally more expensive and is thought by some to be less private. Websites log IP numbers as a matter of course, so an unchanging address creates a rather complete profile of surfing habits across the Internet, easily collected and triangulated by data mining companies.

9.3.3 Track and Record IP Addresses

An IP or Internet Protocol address is a unique numerical address assigned to a computer as it logs on to the Internet. The IP address can be mapped back to a specific individual with help from Internet Service Provider (ISP) records. Virtually every website on the World Wide Web (Web) will track and record IP addresses as visitors click through the site's pages. Two primary reasons for this are security and site improvement.

Every website is hosted on a server. When a visitor clicks his or her way to a website, the user's browser sends a request to the server for a webpage at the location. The server returns the webpage to the IP address on the request. The page subsequently loads on the visitor's computer screen.

If the server is bogged down by traffic (handling many requests at once), pages might load slower for visitors. In the case of an overload of simultaneous requests, the server will "crash" or go down, leaving the site temporarily unavailable. This can be a form of attack, called a Denial Of Service (DoS) attack. If the attack comes from a network of infected computers called a *botnet*, it is referred to a Distributed Denial of Service (DDoS) attack.

A malicious hacker might infiltrate a Web server in an attempt to gain information from protected databases that hold customer data such as credit card numbers. So-called "script kiddies" might simply want to malign a site by uploading images or text to the website.

For these reasons and more, websites track and record IP addresses as a matter of course, storing the numerical addresses in server logs. Each request from the IP address is recorded, along with a time stamp. Older data is routinely purged from logs to make room for newer data. The length of time a website holds on to IP logs is variable, configured by the site's administrator, and dependent upon many factors.

Websites also track and record IP addresses to learn which pages are most popular. The site can build on popular pages to increase site traffic. Tracking IP addresses across the site can also reveal traffic leaks.

A page that provides information about a product might have a link to a remote site with additional information. If server logs reveal that a large amount of traffic is clicking through to the other site, the administrator can improve the page's content or design to keep traffic longer.

Website policies generally refer to IP addresses as "anonymous" data. However, with the help of computer cookies there are many ways for websites to link identities to IP addresses, even when the address is dynamic, or changes with each Web session. Many websites also contain "Web bugs" or a few pixels linked to an advertising firm that can track and record IP addresses across the Web, from one site to another, surreptitiously compiling detailed surfing profiles of individuals over a period of months or years.

A visitor need not register at a website to be tracked and profiled. Typically all visits to a site are time-stamped and recorded to a cookie, if cookies are enabled in the Web browser. All pages and links visited within the site are commonly added to the cookie (in addition to the sever logs). While server logs are purged, cookies are commonly retained. Deleting a cookie from a user's computer does not remove the duplicate cookie on the Web server. Upon a subsequent visit to the site, the server might "recognize" the surfer by various system and software data that browsers routinely hand over; even when the surfer is careful to allow temporary cookies only, or no cookies.

Due to these concerns, many savvy netizens prefer to surf anonymously. In this case a proxy server stands between the surfer's computer and the Web. All browser requests are sent to the proxy which relays them to the Internet. Web servers return pages to the proxy's IP address, logging its address instead. The proxy receives the page, forwarding it on to the surfer, acting as a go-between. Web servers have no record of the surfer's IP address, (however, the proxy server will track and record IP addresses).

If using a proxy service, it is important to know if it is truly anonymous. Some proxy servers forward the requester's IP address in their headers, defeating the purpose. Only anonymous proxy servers hide this information. Some proxy's claim to be anonymous but are not, so personal checking through available proxy tools is advisable. Using international proxies can also increase anonymity because the proxy's logs will not be subject to jurisdiction of the netizen's home country. That said, proxy services are designed to help maintain freedom and privacy for legal activity, not protect illegal activity.

The Firefox™ browser has an add-on plug-in called FoxyProxy which allows users to keep a list of proxies and easily switch between them to keep records from accumulating on just one proxy server. One can also link proxies, placing two or three proxy servers in a chain, however, this slows surfing. Also, if one of the proxies is

DID YOU KNOW ?

During the 1980s, online service providers such as CompuServe and America On Line (AOL) began to offer limited capabilities to access the Internet, such as e-mail interchange, but full access to the Internet was not readily available to the general public.

down requests get lost. Additionally, there are various shareware programs for proxy surfing.

Web-based anonymous services allow visitors to surf the Web through an onsite interface. Surfing from the site, requested pages appear in a window. The only IP address revealed to the Internet is the website's own address. But once again, the website itself will record and track IP addresses of those who use its services.

9.3.4 Difference between Public and Private IP Addresses

Unique Internet Protocol addresses, better known as IP addresses, are used to identify every computer connected to a network, whether it is a private network, such as in a workplace, or the public network that is the World Wide Web. The IP addressing scheme makes it possible for computers to locate each other and exchange information. A public IP address is assigned to every computer that connects to the Internet, while private addresses are used to distinguish between computers on the same local area network (LAN). It's similar to the way phone numbers work within an office; there is usually one main business number for a company (the public IP address), while each employee may have a separate extension so that calls can be routed to the appropriate individual (the private IP address).

An IP address is a series of binary numbers that provide information about the network and the host (the computer or other device). These numbers are typically written as four numbers separated by dots in the older, IP Version 4 (IPv4) address numbering that is most common. Because the number of available addresses in the IPv4 format is limited and running out, a new numbering scheme called IPv6 was devised in the 1990s. In this format, IP addresses are written as eight groups of four letters and numbers separated by colons, although groups with zero value may be omitted. Private addresses are known as "local-use" in IPv6.

Public Addresses

Public IP addresses are those that allow any two computers to identify each other. When a person connects to the Internet, her computer is usually assigned an address from a pool that has been set aside for her Internet Service Provider (ISP) to use for its customers. When she types in a website address — like wisegeek.com — that domain name is converted into the IP address for the server that hosts the website. The server uses the computer's public IP address to know where to send the requested site page.

Private Addresses

When several computers or devices are connected to each other, either with cables or wirelessly, they can make up a private network. Each device within this network is assigned a different IP address in order to exchange files and share resources within the network. Although addresses must be unique within the private network, different private networks could all use the same addresses; since the computers in different networks don't directly communicate, it doesn't matter if they have the same address. A device called a network router passes data back and forth among the connected computers using the private IP addresses as identifiers.

The private network, or one of the computers in the network, usually connects to the Internet through a modem. The router or firewall within the network is assigned a public IP address by the Internet Service Provider (ISP); this single public IP address identifies the entire network on the Internet. Using a built-in device called a Network Address Translator (NAT), the router acts as a gatekeeper and passes requests from individual computer users to the Internet. Returning data is delivered back to the public IP address, with the router determining which private IP address requested the information.

Static and Dynamic

A public IP address can be static or dynamic. A static IP address does not change, and is used primarily for hosting websites or services on the Internet. Some gamers and people who use voice over IP (VOIP) regularly also prefer static IPs because it can make communication easier. A dynamic IP address is chosen from a pool of available addresses, and changes each time a given user connects to the Internet. Most computers have a dynamic public IP address, as it is the standard type of address that is assigned when a user uses the services of an ISP.

Finding a Computer's IP Address

There are many programs available online that allow users to see their computer's assigned public IP addresses, or sometimes, those of other users. It is also possible to see private IP addresses by using the network router's configuration dialogs. Novice computer users may want to consult a network administrator or other professional before attempting to access or change the information in a network router.

Private Ranges

Within the range of publicly available IP addresses there are specific, excluded ranges withheld for private network use. In IPv4, the private IP ranges are as follows:

- 10.0.0.0 ... 10.255.255.255
- 172.16.0.0 ... 172.31.255.255
- 192.168.0.0 ... 192.168.255.255

In IPv6, site-local addresses — the equivalent of IPv4 private addresses — begin with FE followed by C, D, E, or F. Another type, called link-local, does not have a comparison in IPv4 and is only used for special purposes on physical networks. These also begin with FE, followed by 8, 9, A, or B.

Who Coordinates IP Addresses?

The Internet Assigned Numbers Authority (IANA) is responsible for overseeing the global allocation of IP numbers, among other related protocols. IANA, once an autonomous organization, now works under the oversight of the Internet Corporation for Assigned Names and Numbers (ICANN). ICANN is also the organization responsible for assigning and maintaining Internet domain names, such as those ending in .com and .org. IP addresses, domain names, and other identifiers simplify the complicated process of connecting computers with each other so they can readily exchange information.

9.3.5 The TCP/IP network architecture

TCP/IP is a shorthand for the two most important protocols used to make the Internet work. The Internet Protocol (IP) is responsible for transferring these data packets, while the Transmission Control Protocol (TCP) makes sure all packets arrive safely, retransmitting them if necessary. An alternative to TCP is the User Datagram Protocol (UDP), which is an unreliable but fast protocol that is often used for data transfer.

The Internet architecture is made up of five layers that work together. These five layers are, from high to low:

- The Application Layer
- The Transport Layer
- The Network Layer
- The Link Layer
- The Physical Layer

The Application Layer

The application layer defines how certain services operate and how they can be used. Examples are the FTP service for transferring files, HTTP for serving Web pages and SMTP for e-mail.

These services are defined in a rather abstract manner. Two parties, called the client and the server, set up a connection over which they exchange messages in accordance with a specific protocol. The client starts the protocol by requesting the service. Often the next step is for the server to authenticate the client, for example by asking for a password or by executing a public-key based protocol.

Taking e-mail as an example, the protocol in question is called the Simple Mail Transfer Protocol (SMTP). The client and the server set up an SMTP connection over which they exchange identifying information. The client then tells who the message is from and who the intended recipient is. The server then indicates whether it accepts or refuses the message (for example if it's spam or the intended recipient is unknown). If the message is accepted, the client sends the actual content of the message and the server stores it in the right mailbox.

The Transport Layer

On the Internet, the transport layer is realized by two protocols. The first is the Transmission Control Protocol (TCP) and the second is the User Datagram Protocol (UDP). Both break up a message that an application wants to send into packets and attempt to deliver those packets to the intended recipient. At the recipient's side, both take the payload from the received packets and pass those to the application layer.

The main difference between TCP and UDP is that TCP is reliable and UDP is not. TCP will collect incoming packets, put them in the right order and thereby reassemble the original message. If necessary, TCP requests retransmission of lost or damaged packets. UDP merely takes each incoming packet and delivers the payload (the original message) to the application layer. Any errors or out-of-order data should be taken care of by the application.

UDP is much faster than TCP, and so is mainly used for applications like audio and video streaming, where the occasional error is less important than getting all the data there at the right time. More generally, UDP is designed for applications that do not require the packets to be in any specific order. Because of this, UDP is sometimes called a "connection-less" protocol.

Taking the example of e-mail again, the e-mail client and server communicate over a reliable TCP connection. The server listens on a certain port (port 25) until a connection request arrives from the client. The server acknowledges the request, and a TCP connection is established. Using this connection the client and server can exchange data.

The content of this data is not really relevant at this level: that's the responsibility of the application layer. The e-mail message and all the other information exchanged at that SMTP application layer are merely payload, data that needs to be transported. Hence the name transport layer.

The Network Layer

The network layer is responsible for transmitting and routing data packets over the network. The Internet uses the Internet Protocol or IP as its network layer. Each node on the network has an address, which of course is called the IP address. Data is sent as IP packets.

A transport layer connection is made up up of a large number of IP packets exchanged by the client and server. The Internet Protocol (IP) is very simple: a packet has a source, a destination and a payload, and it's passed from one node in the network to another until it gets to the destination. The IP does not notice that a packet gets lost. It just never gets to the destination. If a particular node cannot pass the packet to the next node along the normal route, it will do its best to find an alternative path. That's why IP is sometimes called a "best-effort" protocol.

When the client sends its TCP connection request, the network layer puts the request in a number of packets and transmits each of them to the server. Each packet can take a different route, and some of the packets may get lost along the way. If they all make it, the transport layer at the server is able to reconstruct the request, and it will prepare a response confirming that a TCP connection has been set up. This response is sent back again in a number of IP packets that will hopefully make it to the client.

The Link Layer

The Internet Protocol basically assumes all computers are part of one very large "web" of nodes that can all pass packets to other nodes. There's always a route from one node to another, even if sometimes a very large number of intermediate nodes get involved. The link layer is what makes this assumption true.

The link layer provides a network connection between hosts on a particular local network, as well as interconnection between such local networks. The e-mail client runs on a personal computer in someone's home network, which is set up using the Ethernet protocol. The link layer now is that Ethernet network. The IP packets that this computer transmits, are added as payload to Ethernet packets (called "frames") that are transmitted over the local network to the ADSL modem that connects the local network to the provider.

A different kind of link layer protocol is used to transmit the payload taken from the Ethernet frames from the ADSL modem to the provider. At the provider this payload is again passed forward using yet another link level protocol. The "web of nodes" that the Internet Protocol relies on thus actually is made up of a large number of local networks, each with their own link layer protocol, that each forward the IP packet by putting it into their own kind of message that is then sent over the local network.

The Physical Layer

The lowest layer is the physical layer, which defines how the cables, network cards, wireless transmitters and other hardware connect computers to networks and networks to the rest of the Internet. Examples of physical layer networks are Ethernet, WiFi, Token Ring and Fiber Data Distributed Interface (FDDI). Note that many of these technologies also have their own link layer protocol. Often link and physical layer are closely related.

The physical layer provides the means to transfer the actual bits from one computer to another. In an Ethernet network (a link layer protocol), a computer is connected by plugging a network cable into its Ethernet card, and then plugging the other end of that cable into a router or switch. The physical layer specifies how bits of data are sent over that cable: how do the electrical currents or the pulses the card sends get turned back into the data for the higher level layers. For wireless networks, this works exactly the same, except of course there is no cable.

ROLE MODEL

PAUL BARAN: *HE WAS ONE OF THE TWO INDEPENDENT INVENTORS OF PACKET SWITCHING, WHICH IS TODAY THE DOMINANT BASIS FOR DATA COMMUNICATIONS IN COMPUTER NETWORKS WORLDWIDE, AND WENT ON TO START SEVERAL COMPANIES AND DEVELOP OTHER TECHNOLOGIES THAT ARE AN ESSENTIAL PART OF MODERN DIGITAL COMMUNICATION.*

BIOGRAPHY

Paul Baran, (born April 29, 1926, Grodno, Pol. [now Hrodna, Bela.]—died March 26, 2011, Palo Alto, Calif., U.S.), American electrical engineer, inventor of the distributed network and, contemporaneously with British computer scientist Donald Davies, of data packet switching across distributed networks. These inventions were the foundation for the Internet.

In 1928 Baran's family moved to Philadelphia. Baran studied electrical engineering at Drexel University in Philadelphia (B.S., 1949) and at the University of California, Los Angeles (M.S., 1959). In 1959 he became a researcher at the RAND Corporation, a think tank that provided analyses of various issues affecting public policy and national defense. At RAND, Baran worked on developing a method for U.S. authorities to communicate in the event that their centralized switching facilities were destroyed by a nuclear attack. Influenced by the principle that the human brain can recover lost functions by bypassing a dysfunctional area, Baran conceived a "distributed" network employing digital technology that would have no centralized switches or dedicated transmission lines and that would continue to operate even if several of its switching nodes had been disabled.

For transporting messages across this system, Baran conceived of the idea of breaking large messages or units of computer data into "message blocks"—separate pieces of data that would be sent independently to the target destination, where they would be rejoined into the original message. By foregoing dedicated communication lines in favour of using any number of available circuits, Baran's system increased transmission capacity (bandwidth) and created a flexible, reliable, and robust communications network. Baran's work on message blocks appeared in a series of RAND studies published between 1960 and 1962. At about the same time, Davies in the United Kingdom invented a similar system employing what Davies called "packets," and packet switching, as this process came to be called, formed the basis for communication across modern networks. With digital computers as network nodes, Baran used a "rapid store and forward" design for packet switching, allowing for essentially real-time data transmission.

In the 1970s Baran became an informal consultant to ARPANET, a high-speed computer network created by the Defense Advanced Research Projects Agency (DARPA) to connect research institutes and laboratories supported by the Department of Defense across the United States. Baran's inventions provided the technical foundation for the eventual development at ARPANET of the Transmission Control Protocol/Internet Protocol (TCP/IP), a communications protocol that allowed a number of different networks designed by different vendors to form a "network of networks." ARPANET, based on Baran's packet switching, thus became the predecessor of the Internet.

Baran left RAND in 1968 and afterward was involved with developing discrete multitone technology (a crucial component of digital subscriber lines) and with contributing to developments in spread spectrum transmission (an essential component of wireless communication). Baran also founded Metricom, a wireless Internet service company, in 1986; Com21, a supplier of cable modem systems, in 1992; and GoBackTV, a company specializing in infrastructure equipment for television operators, in 2003.

SUMMARY

- Internetworking is combined of 2 words, inter and networking which implies an association between totally different nodes or segments. This connection area unit is established through intercessor devices akin to routers or gateway.
- Internetworking is the technique of interconnecting myriad networks together, using connecting devices like routers and gateways. The different networks are owned by different entities that widely vary in terms of network technologies.
- Internetwork addresses establish devices severally or as members of a bunch. Addressing schemes differ based on the protocol family and therefore the OSI layer.
- A data-link layer address unambiguously identifies every physical network association of a network device. Data-link addresses typically area unit cited as physical or hardware addresses
- Media Access management (MAC) addresses encompass a set of data-link layer addresses. MAC addresses establish network entities in LANs that implement the IEEE MAC addresses of the data-link layer. MAC addresses different area unit distinctively for every local area network interface.
- Intranets and extranets might or might not have connections to the net. If there is a connection to the net, the computer network or extranet area unit is usually shielded from being accessed from the net if it is not authorized.
- An internetwork is a collection of packet-switching and broadcast networks, connected by bridges, switches, or routers which are intermediate networking devices, that functions as a single large network.
- The Application Layer is the top-most layer, it refers to the higher-level protocols used by applications for network communication such as File Transfer Protocol (FTP), Hyper Text Transfer Protocol (HTTP) and Simple Mail Transfer Protocol (SMTP).
- The application layer provides services for an application program to ensure that effective communication with another application program on a network is possible. The application layer should not be thought of as an application as most people understand it.
- A transport layer is required for transporting data beyond the boundaries of an address space. From the point of view of the transport layer, the data being transported consist of unstructured byte sequences. The transport layer is implemented by a concrete transport mechanism.

KNOWLEDGE CHECK

1. **Configuration where many independent computer systems are connected.**
   a. Complex
   b. Distributed
   c. Cloud
   d. Incremental
2. **Partial mesh is a highly flexible topology that can take a variety of very different configurations.**
   a. True
   b. False
3. **Components used for interconnecting dissimilar networks that use different communication protocols.**
   a. Switches
   b. Gateways
   c. Routers
   d. Bridges
4. **A topology is a modified version of the basic star topology.**
   a. network
   b. two-tiered
   c. bus
   d. ring
5. **WANs that need to interconnect a very large number of sites.**
   a. bus
   b. two-tiered
   c. three-tiered
   d. ring
6. **Components that operate at the network layer of the OSI model.**
   a. Switches
   b. Servers
   c. Routers
   d. Gateways
7. **A topology that involves Tokens.**
   a. Star
   b. Ring

c. Bus

d. Daisy Chaining

8. ____________ operate at bottom two layers of the OSI model.

a. Bridges

b. Switches

c. Models

d. Modules

REVIEW QUESTIONS

1. How to internetwork addressing the connection?
2. Evaluate the unit of internetworking.
3. Give an overview on application layer.
4. Define the importance of network access layer.
5. Examine the characteristics of static IP address.

Check Your Result

1. (b)	2. (a)	3. (b)	4. (b)
5. (c)	6. (c)	7. (b)	8. (a)

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CHAPTER 10

WORKFLOW OF MICROPROCESSOR

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Determine the fundamental of microprocessor
2. Elaborate the 8085 architecture
3. Explain the application of microprocessors

"If transportation technology was moving along as fast as microprocessor technology, then the day after tomorrow I would be able to get in a taxi cab and be in Tokyo in 30 seconds."

—***Danny Hillis***

INTRODUCTION

A microprocessor is a computer processor wherein the data processing logic and control is included on a single integrated circuit, or a small number of integrated circuits. The microprocessor contains the arithmetic, logic, and control circuitry required to perform the functions of a computer's central processing unit. The integrated circuit is capable of interpreting and executing program instructions and performing arithmetic operations. The microprocessor is a multipurpose, clock-driven, register-based, digital integrated circuit that accepts binary data as input, processes it according to instructions stored in its memory, and provides results (also in binary form) as output. Microprocessors contain both combinational logic and sequential digital logic, and operate on numbers and symbols represented in the binary number system.

A microprocessor, sometimes called electronic chip, is a computer processor on a microchip. The microprocessor contains all, or most of, the central processing unit (CPU) functions and is the "engine" that goes into motion when you turn your computer on. A microprocessor is designed to perform arithmetic and logic operations that make use of small number-holding areas called registers. Typical microprocessor operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another. These operations are the result of a set of instructions that are part of the microprocessor design.

8085 microprocessor is an 8-bit microprocessor with a 40 pin dual in line package. The address and data bus are multiplexed in this processor which helps in providing more control signals. 8085 microprocessor has 1 non-mask able interrupt and 3 mask able interrupts. It provides serial interfacing with serial input data (SID) and serial output data (SOD).

10.1 FUNDAMENTAL OF MICROPROCESSOR

A microprocessors is simply a computer processor that has been configured into the design and function of a microchip. Sometimes referred to as a logic chip, this small component functions as the means of executing the command to start booting up a computer. As part of the process, the microprocessor initiates the activation of all the components necessary to allow the computer to be used, such as waking the operating system.

The basic functionality of this processor is all based on its inherent ability to respond to and generate mathematical and logical operations. This is made possible with the use of registers, within which resides all the data required to execute such basic functions as addition and subtraction. The configuration of the registers also allow the microprocessor to handle tasks like comparing two different numbers and retrieving numbers from various areas and redistributing them.

At the core of the design is a series of logical instructions that regulate the order that tasks are received and executed. The presence of the instructions assure that tasks are carried out in a sequence that will flow from the completion of one task and into the logical initiation of the next task in the sequence. For example, when an end user boots up a computer, the first instruction that will be executed is the activation of the BIOS, or basic input/output system. From that point, the BIOS will load the operating system into the active memory and move on to the next task in the starting process. Each successive task will be achieved once the previous task is complete.

Generally, a microprocessor is a component that remains efficient and productive for the life of the computer. It is possible for the functionality of the chip to become damaged in some manner, however, and when this happens, it is usually an easy process for a computer technician to replace the corrupted chip with a fully functioning one.

A Microprocessor is an important part of a computer architecture without which you will not be able to perform anything on your computer. It is a programmable device that takes in input performs some arithmetic and logical operations over it and produces the desired output. In simple words, a Microprocessor is a digital device on a chip that can fetch instructions from memory, decode and execute them and give results.

Microprocessor, any of a type of miniature electronic device that contains the arithmetic, logic, and control circuitry necessary to perform the functions of a digital computer's central processing unit. In effect, this kind of integrated circuit can interpret and execute program instructions as well as handle arithmetic operations.

In the early 1970s the introduction of large-scale integration (LSI)—which made it possible to pack thousands of transistors, diodes, and resistors onto a silicon chip less than 0.2 inch (5 mm) square—led to the development of the microprocessor. The first microprocessor was the Intel 4004, which was introduced in 1971. During the early 1980s very large-scale integration (VLSI) vastly increased the circuit density of microprocessors. In the 2010s a single VLSI circuit holds billions of electronic components on a chip identical in size to the LSI circuit. (For more about the history of microprocessors, see computer: The microprocessor.)

Computers host websites composed of HTML and send text messages as simple as...LOL. Hack into this quiz and let some technology tally your score and reveal the contents to you.

The production of inexpensive microprocessors enabled computer engineers to develop microcomputers. Such computer systems are small but have enough computing power to perform many business, industrial, and scientific tasks. The microprocessor also permitted the development of so-called intelligent terminals, such as automatic teller machines and point-of-sale terminals employed in retail stores. The microprocessor also provides automatic control of industrial robots, surveying instruments, and various kinds of hospital equipment. It has brought about the computerization of a wide array of consumer products, including programmable microwave ovens, television sets, and electronic games. In addition, some automobiles feature microprocessor-controlled ignition and fuel systems designed to improve performance and fuel economy.

Advantages of microprocessor –

- High processing speed
- Compact size
- Easy maintenance
- Can perform complex mathematics
- Flexible
- Can be improved according to requirement

Disadvantages of microprocessors –

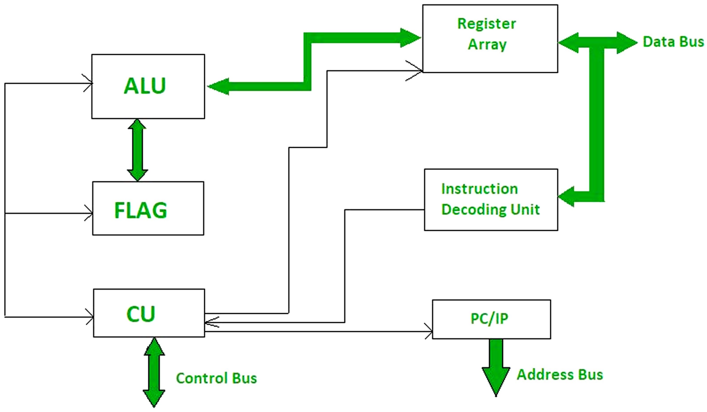
- Overheating occurs due to overuse
- Performance depends on size of data
- Large board size than microcontrollers
- Most microprocessors do not support floating point operations

10.1.1 Basics of Microprocessor

A Microprocessor takes a bunch of instructions in machine language and executes them, telling the processor what it has to do. Microprocessor performs three basic things while executing the instruction:

- It performs some basic operations like addition, subtraction, multiplication, division, and some logical operations using its Arithmetic and Logical Unit (ALU). New Microprocessors also perform operations on floating-point numbers also.
- Data in microprocessors can move from one location to another.
- It has a Program Counter (PC) register that stores the address of the next instruction based on the value of the PC, Microprocessor jumps from one location to another and takes decisions.

A typical Microprocessor structure looks like this.



Clock Speed of different Microprocessor:

- **16-bit Microprocessor –**
  - 8086: 4.7MHz, 8MHz, 10MHz
  - 8088: more than 5MHz
  - 80186/80188: 6MHz
  - 80286: 8MHz
- **32-bit Microprocessor –**
  - INTEL 80386: 16MHz to 33MHz
  - INTEL 80486: 16MHz to 100MHz
  - PENTIUM: 66MHz
- **64-bit Microprocessor –**
  - INTEL CORE-2: 1.2GHz to 3GHz
  - INTEL i7: 66GHz to 3.33GHz
  - INTEL i5: 2.4GHz to 3.6GHz
  - INTEL i3: 2.93GHz to 3.33GHz

We do not have any 128-bit Microprocessor at work at present one of the reasons for this is that we are a long way from exhausting the 64-bit address space itself, we use it at a constant rate of roughly 2 bits every 3 years. At present we have only used 48 bits of 64 bits so why require 128-bit address space. Also, 128-bit Microprocessor would be much slower than the 64 bit Microprocessor.

10.1.2 Types of Processor

- **Complex Instruction Set Computer (CISC) –**CISC or Complex Instruction Set Computer is a computer architecture where instructions are such that a single instruction can execute multiple low-level operations like loading from memory, storing into memory, or an arithmetic operation, etc. It has multiple addressing nodes within a single instruction. CISC makes use of very few registers.

Example:

- 1. Intel 386
- 2. Intel 486
- 3. Pentium
- 4. Pentium Pro
- 5. Pentium II
- 6. Pentium III
- 7. Motorola 68000
- 8. Motorola 68020
- 9. Motorola 68040 etc.
- **Reduced Instruction Set Computer (RISC)** RISC or Reduced Instruction Set Computer is a computer architecture where instruction is simple and designed to get executed quickly. Instructions get completed in one clock cycle this is because of the optimization of instructions and pipelining (a technique that allows for simultaneous execution of parts, or stages, of instructions more efficiently process instructions). RISC makes use of multiple registers to avoid large interactions with memory. It has few addressing nodes.

Example:

1. IBM RS6000
2. MC88100
3. DEC Alpha 21064
4. DEC Alpha 21164
5. DEC Alpha 21264

- **Explicitly Parallel Instruction Computing (EPIC).** EPIC or Explicitly Parallel Instruction Computing permits computers to execute instructions parallel using compilers. It allows complex instructions execution without using higher clock frequencies. EPIC encodes its instruction into 128-bit bundles. Each bundle contains three instructions which are encoded in 41 bits each and a 5-bit template field (contains information about types of instructions in a bundle and which instructions can be executed in parallel).

Example:

1. IA-64 (Intel Architecture-64)

10.1.3 Generations of Microprocessor

- **First generation –** From 1971 to 1972 the era of the first generation came which brought microprocessors like INTEL 4004 Rockwell international PPS-4 INTEL 8008 etc.
- **Second generation –** The second generation marked the development of 8 bit microprocessors from 1973 to 1978. Processors like INTEL 8085 Motorola 6800 and 6801 etc. came into existence.
- **Third generation –** The third generation brought forward the 16 bit processors like INTEL 8086/80186/80286 Motorola 68000 68010 etc. From 1979 to 1980 this generation used the HMOS technology.
- **Fourth generation –** The fourth generation came into existence from 1981 to 1995. The 32 bit processors using HMOS fabrication came into existence. INTEL 80386 and Mororola 68020 are some of the popular processors of this generation.
- **Fifth generation –** From 1995 till now we are in the fifth generation. 64 bit processors like PENTIUM, celeron, dual, quad and octa core processors came into existence.

10.1.4 Types of Microprocessors

- **Complex instruction set microprocessor –** The processors are designed to minimize the number of instructions per program and ignore the number of cycles per instructions. The compiler is used to translate a high level language to assembly level language because the length of code is relatively short and an extra RAM is used to store the instructions. These processors can do tasks like downloading, uploading and recalling data from memory. Apart from these tasks these microprocessor can perform complex mathematical calculation in a single command. Example: IBM 370/168, VAX 11/780
- **Reduced instruction set microprocessor –**These processor are made according to function. They are designed to reduce the execution time by using the simplified instruction set. They can carry out small things in specific commands. These processors complete commands at faster rate. They require only one clock cycle to implement a result at uniform execution time. There are number of registers and less number of transistors. To access the memory location LOAD and STORE instructions are used. Example: Power PC 601, 604, 615, 620
- **Super scalar microprocessor –** These processors can perform many tasks at a time. They can be used for ALUs and multiplier like array. They have multiple operation unit and perform tasks by executing multiple commands.

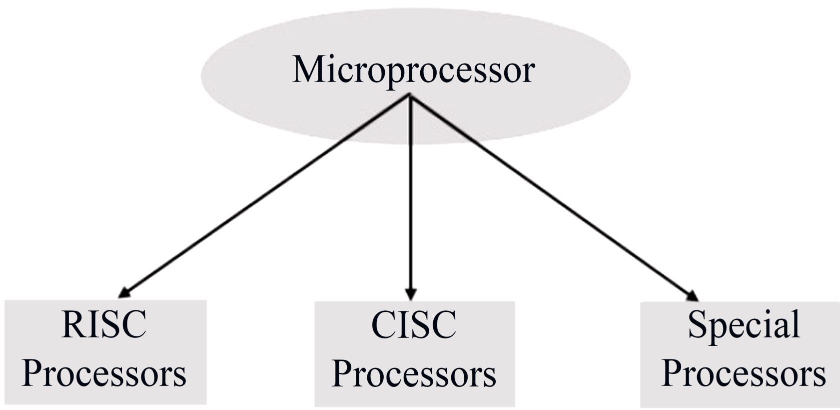
- **Application specific integrated circuit –** These processors are application specific like for **personal digital assistant** computers. They are designed according to proper specification.
- **Digital signal multiprocessor –** These processors are used to convert signals like analog to digital or digital to analog. The chips of these processors are used in many devices such as RADAR SONAR home theatres etc.

Keyword

Personal digital assistant is a variety mobile device which functions as a personal information manager. PDAs have been mostly displaced by the widespread adoption of highly capable smartphones, in particular those based on iOS and Android.

10.1.5 Classification

A microprocessor can be classified into three categories –



RISC Processor

RISC stands for Reduced Instruction Set Computer. It is designed to reduce the execution time by simplifying the instruction set of the computer. Using RISC processors, each instruction requires only one clock cycle to execute results in uniform execution time. This reduces the efficiency as there are more lines of code, hence more RAM is needed to store the instructions. The compiler also has to work more to convert high-level language instructions into machine code.

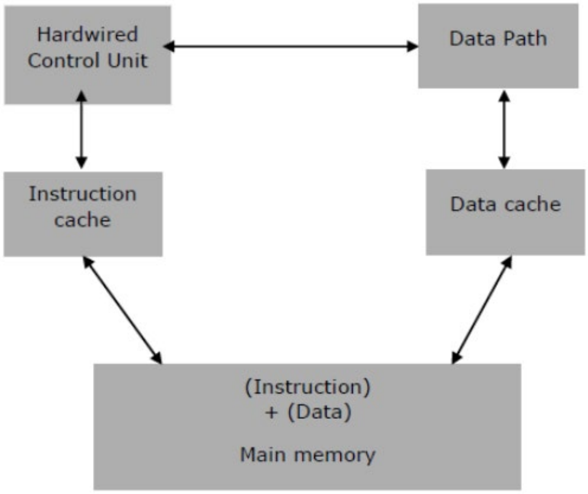
Some of the RISC processors are –

- Power PC: 601, 604, 615, 620
- DEC Alpha: 210642, 211066, 21068, 21164
- MIPS: TS (R10000) RISC Processor

- PA-RISC: HP 7100LC

Architecture of RISC

RISC microprocessor architecture uses highly-optimized set of instructions. It is used in portable devices like Apple iPod due to its power efficiency.



Characteristics of RISC

The major characteristics of a RISC processor are as follows −

- It consists of simple instructions.
- It supports various data-type formats.
- It utilizes simple addressing modes and fixed length instructions for pipelining.
- It supports register to use in any context.
- One cycle execution time.
- "LOAD" and "STORE" instructions are used to access the memory location.
- It consists of larger number of registers.
- It consists of less number of transistors.

CISC Processor

CISC stands for Complex Instruction Set Computer. It is designed to minimize the number of instructions per program, ignoring the number of cycles per instruction. The emphasis is on building complex instructions directly into the hardware.

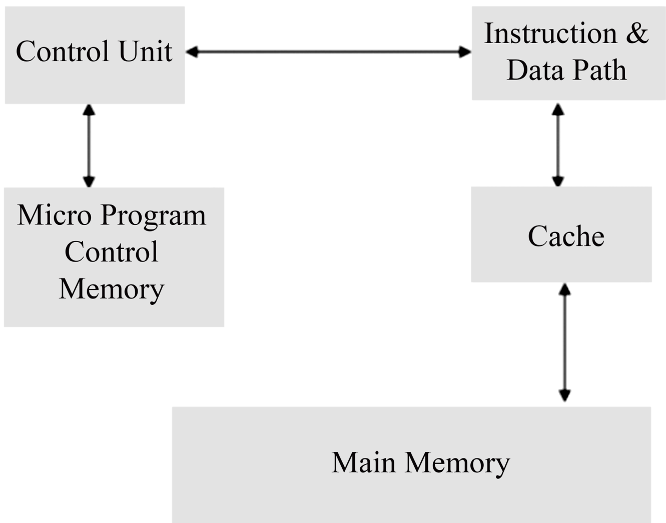
The compiler has to do very little work to translate a high-level language into assembly level language/machine code because the length of the code is relatively short, so very little RAM is required to store the instructions.

Some of the CISC Processors are –

- IBM 370/168
- VAX 11/780
- Intel 80486

Architecture of CISC

Its architecture is designed to decrease the memory cost because more storage is needed in larger programs resulting in higher memory cost. To resolve this, the number of instructions per program can be reduced by embedding the number of operations in a single instruction.



Characteristics of CISC

- Variety of addressing modes.
- Larger number of instructions.
- Variable length of instruction formats.
- Several cycles may be required to execute one instruction.
- Instruction-decoding logic is complex.
- One instruction is required to support multiple addressing modes.

Special Processors

These are the processors which are designed for some special purposes. Few of the special processors are briefly discussed −

Coprocessor

A coprocessor is a specially designed microprocessor, which can handle its particular function many times faster than the ordinary microprocessor.

For example − Math Coprocessor.

Some Intel math-coprocessors are −

- 8087-used with 8086
- 80287-used with 80286
- 80387-used with 80386

Input / Output Processor

It is a specially designed microprocessor having a local memory of its own, which is used to control I/O devices with minimum CPU involvement.

For example −

- DMA (direct Memory Access) controller
- Keyboard/mouse controller
- Graphic display controller
- SCSI port controller

Transputer (Transistor Computer)

A transputer is a specially designed microprocessor with its own local memory and having links to connect one transputer to another transputer for inter-processor communications. It was first designed in 1980 by Inmos and is targeted to the utilization of VLSI technology.

A transputer can be used as a single processor system or can be connected to external links, which reduces the construction cost and increases the performance.

For example − 16-bit T212, 32-bit T425, the floating point (T800, T805 & T9000) processors.

DSP (Digital Signal Processor)

This processor is specially designed to process the analog signals into a digital form. This is done by sampling the voltage level at regular time intervals and converting the voltage at that instant into a digital form. This process is performed by a circuit called an analogue to digital converter, A to D converter or ADC.

A DSP contains the following components –

- **Program Memory** – It stores the programs that DSP will use to process data.
- **Data Memory** – It stores the information to be processed.
- **Compute Engine** – It performs the mathematical processing, accessing the program from the program memory and the data from the data memory.
- **Input / Output** – It connects to the outside world.

Its applications are –

- Sound and music synthesis
- Audio and video compression
- Video signal processing
- 2D and 3d graphics acceleration.

For example – Texas Instrument's TMS 320 series, e.g., TMS 320C40, TMS320C50.

Keyword

Arithmetic logic unit (ALU) is a combinational digital circuit that performs arithmetic and bitwise operations on integer binary numbers.

10.2 8085 ARCHITECTURE

Microprocessor is a program-controlled device, which fetches the instructions from memory, decodes and executes the instructions. Most microprocessor are single- chip devices. The functional block diagram or architecture of 8085 microprocessor, gives the complete details about the internal microprocessor. It includes the **arithmetic and logic unit (ALU)**, timing and control unit, instruction registers and decoder, register array, interrupt control, and serial I/O control etc.

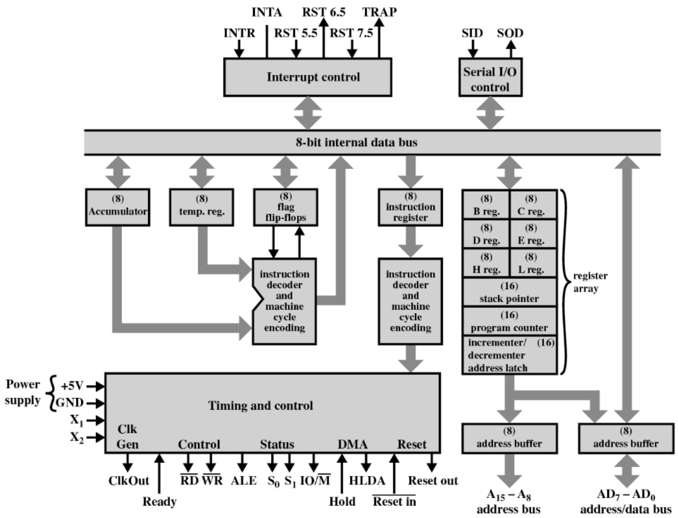


Figure 10.1: Block diagram of 8085 microprocessor.

Bus Structure of Microcomputer

The major parts of microcomputers are central processing unit (CPU), memory, and input and output unit. To connect these parts together through three sets of parallel lines, called buses. These three buses are address bus, data bus, and control bus.

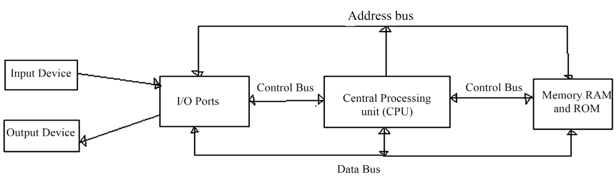


Figure 10.2: Bus structure of microcomputer.

Address Bus

The **address bus** consists of 16, 20, 24, or more parallel signal lines, through which the CPU sends out the address of the memory location. This memory location is used for to written to or read from. The number of memory location is depends on 2 to the power N address lines.

Example, a CPU with 16 address lines can address 2^{16} or 65,536 memory locations. When the CPU reads data from or writes data to a port. The port address is also sent out on the address bus. This is unidirectional. This means that the CPU can send data to a memory location or I/O ports.

Data Bus

The data bus consists of 8, 16, 32 or more parallel signal lines. The data bus lines are bidirectional. This means that the CPU can read data from memory or from a I/O port as well as send data to a memory location or to a I/O port. In a system, many output devices are connected to the data bus, but only one device at a time will be enabled to the output.

Keyword

Address bus is a computer bus architecture used to transfer data between devices that are identified by the hardware address of the physical memory (the physical address), which is stored in the form of binary numbers to enable the data bus to access memory storage.

Control Bus

The control bus consists of 4-10 parallel signal lines. The CPU sends out signals on the control bus to enable the outputs of addressed memory devices or port devices. Typically control bus signals are memory read, memory write, I/O read and I/O write. To read a data from a memory location, the CPU sends out the address of the desired data on the address bus and then sends out a memory read signal on the control bus. The memory read signal enables the addressed memory device to output the data onto the data bus where it is read by the CPU.

Accumulator

It is a 8-bit register which is used to perform arithmetical and logical operation. It stores the output of any operation. It also works as registers for i/o accesses.

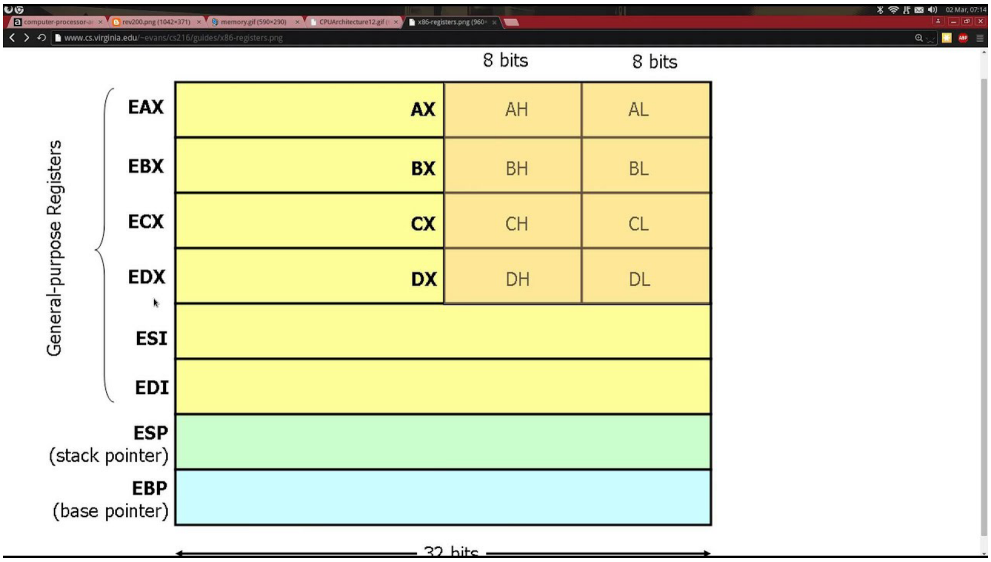
Temporary Register

It is a 8-bit register which is used to hold the data on which the accumulator is computing operation. It is also called as operand register because it provides operands to ALU.

Registers

These are general purposes registers. Microprocessor consists 6 general purpose registers of 8-bit each named as B, C, D, E, H and L. Generally theses registers are not used for storing the data permanently. It carries the 8-bits data. These are used only during the execution of the instructions.

These registers can also be used to carry the 16 bits data by making the pair of 2 registers. The valid register pairs available are BC, DE, and HL. We cannot use other pairs except BC, DE and HL. These registers are programmed by user.



ALU

ALU performs the arithmetic operations and logical operation.

Flag Registers

It consists of 5 flip flop which changes its status according to the result stored in an accumulator. It is also known as status registers. It is connected to the ALU.

There are five flip-flops in the flag register are as follows:

- Sign(S)
- zero(z)
- Auxiliary carry(AC)
- Parity(P)
- Carry(C)

The bit position of the flip flop in flag register is:

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
S	Z		AC		P		CY

All of the three flip flop set and reset according to the stored result in the accumulator.

Sign

If D7 of the result is 1 then sign flag is set otherwise reset. As we know that a number on the D7 always desides the sign of the number.

- if D7 is 1: the number is negative
- if D7 is 0: the number is positive

Zeros (Z)

If the result stored in an accumulator is zero then this flip flop is set otherwise it is reset.

Auxiliary carry (AC)

If any carry goes from D3 to D4 in the output then it is set otherwise it is reset.

Parity (P)

If the no of 1′s is even in the output stored in the accumulator then it is set otherwise it is reset for the odd.

Carry(C)

If the result stored in an accumulator generates a carry in its final output then it is set otherwise it is reset.

Instruction registers (IR)

It is an 8-bit register. When an instruction is fetched from memory then it is stored in this register.

Instruction Decoder

Instruction decoder identifies the instructions. It takes the information's from instruction register and decodes the instruction to be performed.

Program Counter (PC)

Program Counter (PC) is 16-bit register sequencing the execution of instructions in memory that why it is also called as memory pointer. The function of the program counter is to point out the memory address of the next instruction which is to be executed. When an operation code is being fetched, the program counter is incremented by one to point out the next memory location.

The program counter is set to 0000H.

Stack Pointer (SP)

The stack pointer is also a 16-bit register used as a memory pointer. It points to a memory location in R/W memory, called the stack. The beginning of the stack is defined by loading a 16-bit address in the stack pointer (register).

Timing and Control Unit

It provides timing and control signal to the microprocessor to perform the various operation. It has three control signal. It controls all external and internal circuits. It operates with reference to clock signal. It synchronizes all the data transfers.

There are three control signal:

- *ALE*-Arithmetic Latch Enable, It provides control signal to synchronize the components of microprocessor.
- *RD*- This is active low used for reading operation.
- *WR*-This is active low used for writing operation.

There are three status signal used in microprocessor S0, S1 and IO/M. It changes its status according the provided input to these pins.

IO/M (Active low)	S1	S2	Data Bus Status (output)
0	0	0	Halt
0	0	1	Memory Write
0	1	0	Memory Read
1	0	1	IO Write
1	1	0	IO Read
0	1	1	Opcode fetch
1	1	1	Interrupt acknowledge

Serial I/O control section

The input and output of serial data can be carried out using 2 instructions in 8085

- SID-Serial Input Data
- SOD-Serial Output Data

Two more instructions are used to perform serial-parallel conversion needed for serial I/O devices.

Instruction register and decoder

Instruction register is 8-bit register just like every other register of microprocessor. The instruction may be anything like adding two data's, moving a data, copying a data etc. When such an instruction is fetched from memory, it is directed to Instruction register. So the instruction registers are specifically to store the instructions that are fetched from memory. There is an Instruction decoder which decodes the information present in the **Instruction register** for further processing.

Keyword

Instruction register is the part of a CPU's control unit that holds the instruction currently being executed or decoded.

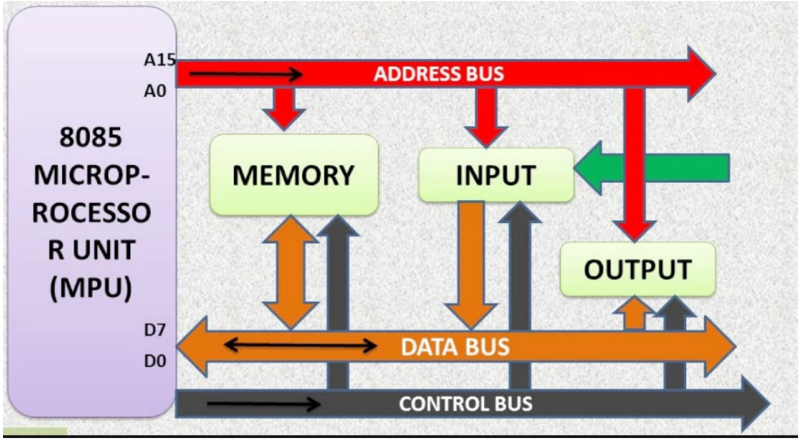
10.2.1 Bus Structure of 8085 Microprocessor

The microprocessor MPU performs various operations with peripheral devices or a memory location by using three sets of communication lines called buses: the address bus, the data bus and the control bus. And these three combined lines is called as system bus.

There are three buses in microprocessor:

- Address Bus
- Data Bus

- Control Bus



Address Bus in Microprocessor

Microprocessor has 16 bit address bus. The bus over which the CPU sends out the address of the memory location is known as Address bus. The address bus carries the address of memory location to be written or to be read from.

The address bus is unidirectional. It means bits flowing occurs only in one direction, only from microprocessor to peripheral devices.

We can find that how much memory location it can using the formula 2^N. where N is the number of bits used for address lines.

here, 2^16 = 65536bytes or 64Kb

So we can say that it can access up to 64 kb memory location.

Data Bus in Microprocessor

8085 Microprocessor has 8 bit data bus. So it can be used to carry the 8 bit data starting from 00000000H (00H) to 11111111H (FFH).

Here 'H' tells the Hexadecimal Number. It is bidirectional. These lines are used for data flowing in both direction means data can be transferred or can be received through these lines. The data bus also connects the I/O ports and CPU. The largest number that can appear on the data bus is 11111111.

It has 8 parallel lines of data bus. So it can access upto 2^8 = 256 data bus lines.

Control Bus in Microprocessor

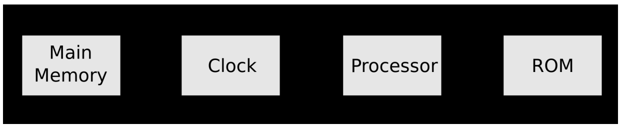
The control bus is used for sending control signals to the memory and I/O devices. The CPU sends control signal on the control bus to enable the outputs of addressed memory devices or I/O port devices.

Some of the control bus signals are as follows:

- Memory read
- Memory write
- I/O read
- I/O write.

10.2.2 Difference between Address and Data Bus

According to computer architecture, a bus is defined as a system that transfers data between hardware components of a computer or between two separate computers. Initially, buses were made up using electrical wires, but now the term bus is used more broadly to identify any physical subsystem that provides equal functionality as the earlier electrical buses. Computer buses can be parallel or serial and can be connected as multi drop, daisy chain or by switched hubs. System bus is a single bus that helps all major components of a computer to communicate with each other. It is made up of an address bus, data bus and a control bus. The data bus carries the data to be stored, while address bus carries the location to where it should be stored.



Address Bus

Address bus is a part of the computer system bus that is dedicated for specifying a physical address. When the computer processor needs to read or write from or to the memory, it uses the address bus to specify the physical address of the individual memory block it needs to access (the actual data is sent along the data bus). More correctly, when the **processor** wants to write some data to the memory, it will assert the write signal, set the write address on the address bus and put the data on to the data bus. Similarly, when the processor wants to read some data residing in the memory, it will assert the read signal and set the read address on the address bus. After receiving this signal, the memory controller will get the data from the specific memory block (after checking the address bus to get the read address) and then it will place the data of the memory block on to the data bus.

The size of the memory that can be addressed by the system determines the width of the data bus and vice versa. *For example*, if the width of the address bus is 32 bits, the system can address 232 memory blocks (that is equal to 4GB memory space, given that one block holds 1 byte of data).

Data Bus

A data bus simply carries data. Internal buses carry information within the processor, while external buses carry data between the processor and the memory. Typically, the same data bus is used for both read/write operations. When it is a write operation, the processor will put the data (to be written) on to the data bus. When it is the read operation, the memory controller will get the data from the specific memory block and put it in to the data bus.

- The data bus consists of 8, 16 or 32 parallel lines.
- The data bus is a bi-directional bus. That means the data can get transferred from CPU to memory and vice versa.
- The data bus also connects the I/O ports and CPU. So the CPU can write data to or read it from the memory or I/O ports.
- The number of data lines used in the data bus is equal to the size of data word being Written or read.
- Many devices in the system will connect their outputs to the same data bus. But only one device at a time will have its output enabled, so that there is no collision of information.
- In order to completely eliminate the possibility of more than one devices putting their outputs simultaneously on the data bus, all the devices getting connected to data bus should have three state outputs.
- This will make it possible to disable the outputs of devices which should be stopped from connecting their outputs to the data bus.

Keyword

Processor is the logic circuitry that responds to and processes the basic instructions that drive a computer.

10.2.3 Microcomputer and Microprocessor

Microcomputers are much smaller computer. They operate still more slowly and they work with still smaller data words (typically 4 bits, 8 bits, 16 bits or 32 bits).

They can address few thousands to few million memory location. One of the important feature of microcomputer is that the CPU is usually a single IC called as a microprocessor.

- A microprocessor has a CPU to which we have to add ROM, RAM and ports to make a microcomputer.
- Application of microcomputer are from sewing machine, washing machine and other domestic appliances to computer added design system.
- Intel 8051 is a microcomputer which is actually a single chip computer.

DID YOU KNOW ?

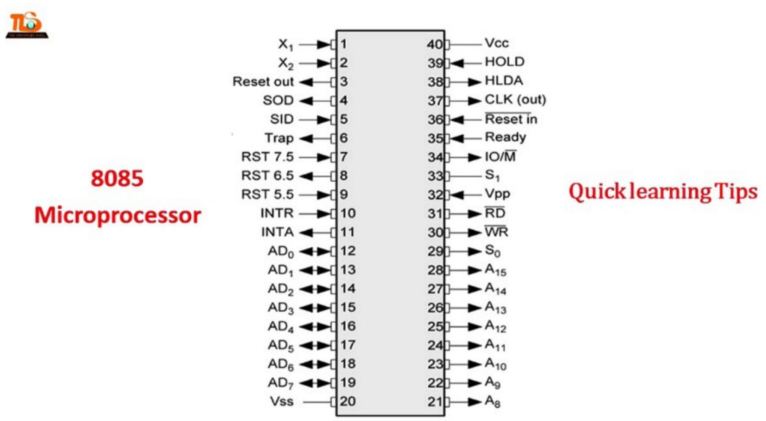
Microcomputers became popular in the 1970s and 1980s with the advent of increasingly powerful microprocessors. The predecessors to these computers, mainframes and minicomputers, were comparatively much larger and more expensive.

10.2.4 Pin Diagram of 8085

8085 is a general purpose microprocessor having 40 pins and works on single power supply.

To study the pin diagram, we group the signals into 5 categories:

- Power supply
- Clock signals
- Interrupt signals
- Address and data bus
- Control and status signals
- Serial I/O port
- DMA request signals



Power Supply and Clock Signals

VCC:-Vcc is to be connected to +5V power supply.

Vss:-Ground reference

X_1 and X_2:- This pin is used for providing the clock frequency to the microprocessor. Generally Crystal oscillator or LC oscillator is used to generate the frequency. The frequency generated here is internally divided into two. As we know that the basic operating timing frequency of the microprocessor is 3 MHz so

6 MHz frequency is applied.

Interrupt Signals

Pin 6 to 11:- These pins are used for interrupt signals. Generally and external devices are connected here which requests the microprocessor to perform a particular task.

There are 5 pins for hardware interrupts-

TRAP, RST7.5, RST 6.5, RST5.5 and INTR

INTA is used for acknowledgement. Microprocessor sends the acknowledgement to external devices through the INTA pin.

Address and Data bus

AD0-AD7:-These are multiplexed address and data bus. So it can be used to carry the lower order 8 bit address as well as the data. Generally these lines are demultiplexed using the Latch.

During the opcode fetch operation, in the first clock cycle the lines deliver the lower order address bus A_0-A_7.

In the subsequent IO/M read or write it is used as data bus D_0-D_7. CPU can read or write data through these lines.

A_8-A_{15}:- These are address bus used to address the memory location.

Control and Status Signals

S_0 and S_1:-It is used for the status signal in microprocessor.

ALE (Arithmetic Latch Enable):-This signal is used to capture the lower address presented on multiplexed address and data bus.

RD:-This is active low input generally used for reading operation.

WR:-This is active low input used for writing operation.

IO/M:-This pin is used to select the memory or input-output through which we want to communicate the data.

Ready:-As we know that memory and input -output have slower response than microprocessor. So a microprocessor may now be able to handle further data till it completes the present job. So it is in waiting state. As it completes the present job it sets the ready pin. Microprocessor enters into wait state while ready pin is disabled.

Reset In:-This is active low input. This pin is used to reset the microprocessor. An active low signal applied to this pin reset the program counter inside the microprocessor.

Reset out:-If we want to reset the external devices connected to the microprocessor then a signal applied to this pin resets the external devices.

Serial I/O Port

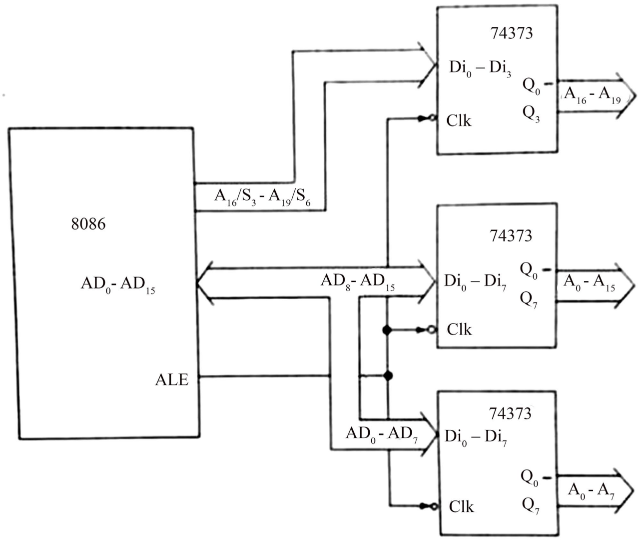
SID and SOD:-These pins are used for serial data communication.

DMA Request Signals

HOLD and HLDA:-HOLD is an active high input signal used by the other controller to request microprocessor about use of address, data and control signal. The HOLD and HLDA signal are used for direct memory access (DMA). DMA controller receives a requests from a device and in turn issues the HOLD signal to the microprocessor.

10.2.5 Multiplexing Address and Data bus

Generally, 74LS373 Latch IC is used for latching the address issued by Microprocessor. It has 8-latches (D-flip flop).



Address will appear on AD_0-AD_7 lines.

ALE will go high and forcing enable G pin of Latch. This will make the latch transparent. It means whatever will be input, will be output. Presently input address is A_0-A_7.Therefore output is A_0-A_7.

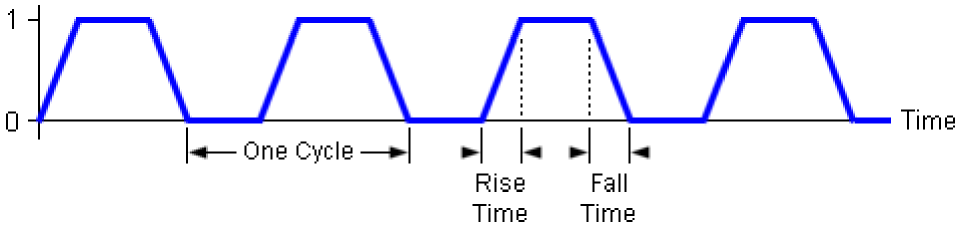
When ALE=0, then AD_0-AD_7 will now be used as data bus.

Representation of Signals in Timing Diagram

There are some representation of signals in timing diagram of 8085, such as:

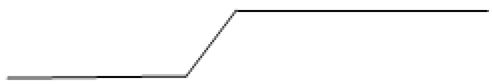
Clock Signals

As we know that the microprocessor operates with reference to clock signals provided to it. At pins X_1 and X_2 we provide clock signals and this frequency is divided by two. This frequency is called as the operating frequency.



Single Line Signal

The status of single line will be either LOW or HIGH. But the change from one state to another state is not possible in zero time.



Multiple Line Signals

In Microprocessor we have multiple lines. If a single line changes occur then we have to crossing to indicate change in contents.

10.3 APPLICATION OF MICROPROCESSORS

A microprocessor is usually a silicon chip that contains millions of transistors and other components that process millions of instructions per second integrated with memory chips and other special purpose chips, and directed by software. It is a multipurpose, programmable microchip that uses digital data as input and provides results as an output once it processes the input according to instructions stored in its memory. Microprocessors use sequential digital logic as they have internal memory and operate on numbers and symbols represented in the binary numeral system. They are designed to perform arithmetic and logic operations that make use of data on the chip. General purpose microprocessors in PCs are used for multimedia display, computation, text editing and communication. Several **microprocessors** are part of embedded systems.

DID YOU KNOW ?

The first use of the term "microprocessor" is attributed to Viatron Computer Systems describing the custom integrated circuit used in their System 21 small computer system announced in 1968

These embedded microprocessors provide digital control to several objects including appliances, automobiles, mobile phones and industrial process control A microprocessor is also known as a central processing unit (CPU), which is a complete computing engine assembled on a single chip. It performs all the computational tasks, calculations and data processing of the computer. The most popular type of microprocessor is the Intel Pentium chip. A typical example is shown in Figure.

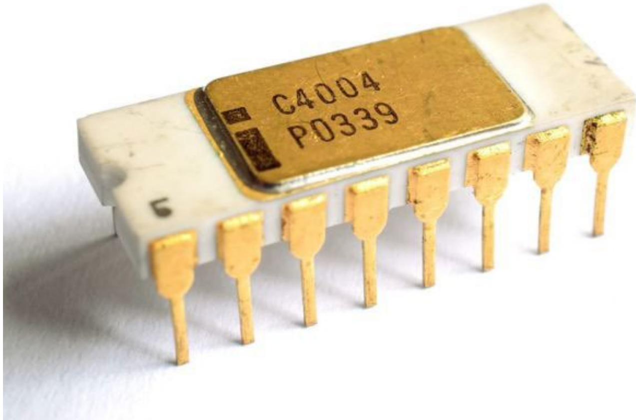


Figure 10.3: Intel 4004 microprocessor.

The development of the first microprocessor began in 1969, when Intel engineer Marcian Edward "Ted" Hoff proposed to use a single-chip, general-purpose CPU to perform most computer programming functions. The result was the first microprocessor, the 4004, which was announced by Intel in 1971. This microprocessor evolved into a series of increasingly powerful Intel chips--the 286, 386, 486, and in 1993, the Pentium--for the International Business Machines (IBM) Corp. Personal computer (PC) and IBM-compatible PCs. Meanwhile, Motorola Corp. developed the 68000 series of chips for the Macintosh personal computer made by Apple Computer.

The function of the microprocessor is best described in a three-step process – fetching, processing, and decoding. In the fetching step, it gets an instruction from the computer's memory. In the decoding step, it decides what the instruction means. The last step is the processing itself, which involves the microprocessor's carrying out or performing the decoded set of instructions. A modern microprocessor can complete this three-step process millions of times in one second.

Microprocessors may be classified by their hardware architecture. The two basic types of hardware are complex instruction set computer (CISC), and reduced instruction set computer (RISC). CISC processors can perform complex functions with one instruction while RISC chips usually need multiple instructions. The Intel Pentium and Atom chips are based on the CISC architecture, while PowerPC and ARM's Cortex chips are RISC systems.

The following are examples of microprocessor: AMD, ARM DEC, Elbrus, Fairchild Semiconductor, Freescale Semiconductor (Motorola), Hewlett-Packard, IBM, Intel, MIPS Technologies, National Semiconductors, NEC, NXP (Phillips), SPARC, Texas, VIA, Western Electronic, Zilog. Each of these microprocessors has their versions and kinds

There are two primary manufacturers of computer microprocessors. Intel and Advanced Micro Devices (AMD) lead the market in terms of speed and quality. Intel's desktop CPUs include Celeron, Pentium and Core. AMD's desktop processors include Sempron, Athlon and Phenom. Intel makes Celeron M, Pentium M and Core mobile processors for notebooks. AMD makes mobile versions of its Sempron and Athlon, as well as the Turion mobile processor which comes in Ultra and Dual-Core versions. Both companies make both single-core and multicore processors.

Each processor has a clock speed which is measured in gigahertz (GHz). It also has a front side bus which connects it with the system's random access memory (RAM.) CPUs typically have two or three levels of cache. Cache is a type of fast memory which serves as a buffer between RAM and the processor. The processor's socket type determines the motherboard type where it can be installed. The basic things to consider when choosing processors are size, front side bus (FSB) and cache. Whether one is buying a new computer or upgrading old one, one must get the fastest affordable processor. This is because the processor becomes obsolete very quickly

The impact of microprocessor in different fields is significant. The availability of low cost, low power and small weight, computing capability makes it useful in different applications. Nowadays, microprocessor-based systems are used in instructions, automatic testing product, speed control of motors, traffic light control, light control of furnaces etc. This work presents the general application of microprocessor to different fields.

Several items such as DVD players, cellular telephones, household appliances, car equipment, toys, light switches and dimmers, electrical circuit breakers, smoke alarms, battery packs, car keys, power tool and test instruments use microprocessors. Pollution control standards require automobile manufacturers to use microprocessor engine management systems for an optimal control of emissions over varying operating conditions. A typical microprocessor makes daily life easier because of its vast application in every field. The applications of microprocessors to life include but not limited to the following:

Household Devices.

A complex home security system or the programmable thermostat neatly attached to the wall contains microprocessor technology. Technology-based home security system microprocessors assist with monitoring large or small properties. The simplest programmable thermostat allows the control of temperature in homes. Entering the preferred degree and achieving it on a consistent basis requires some intelligence on the part of the thermostat. A microprocessor in the system works with the temperature sensor to determine and adjust the temperature accordingly. Dishwashers, washing machines, high-end coffee makers and radio clocks contain microprocessor technology. Some home items that contain microprocessors include televisions, VCRs, DVD players, microwaves, toasters, ovens, stoves, clothes washers, stereo systems, home computers, hand-held game devices, thermostats, video game systems, alarm clocks, bread machines, dishwashers, home lighting systems and even some refrigerators with digital temperature control.

REMEMBER

Microprocessors work behind the scenes to keep commuters safe and timely. Consumer vehicles-cars, trucks, RVs- integrate microprocessors to communicate important information throughout the vehicle.

Industrial Applications of Microprocessors

Some industrial items with microprocessors include: cars, boats, planes, trucks, heavy machinery, gasoline pumps, credit-card processing units, traffic control devices, elevators, computer servers, most high tech medical devices, digital kiosks, security systems, surveillance systems and even some doors with automatic entry.

Transportation Industry

Automobiles, trains and planes utilize microprocessor technology. The 1978 Cadillac Seville was the first consumer vehicle to use a microprocessor embedded in its digital display. The “Trip Computer” provided mileage and additional information on the current trip.

For example, navigation systems provide information using microprocessors and global positioning system (GPS) technology. In addition, mass transportation systems like flights and trains rely on microprocessors for important information. Public transportation fare cards, or smartcards, contain processors to calculate fares, deduct the appropriate amount and retain information on how much funding remains. The aviation system relies heavily on microprocessors from calculating weather conditions to controlling the complex functions of an airplane.

Computers and Electronics

The brain of the computer is microprocessor-drives technology. They are used in computer ranging from microcomputers to supercomputers. In addition, many electronic devices have central processing units (CPU) embedded. The CPU performs computer processing tasks by executing software instructions relative to the data it contains.

example

A cell phone or mobile device executes game instructions by way of the microprocessor. While playing chess, the microprocessor holds data about the last action and executes software instructions for the next computer move. VCRs, televisions and gaming platforms also contain microprocessors for executing complex tasks and instructions.

Low-Power and Battery Management

The need for a processor in battery powered devices has spurred development of microcontrollers that draw little power, yet deliver the processing speed needed in small consumer devices. In some instances, the microcontrollers serve as battery management devices for monitoring the charging and discharging of batteries, such as lithium ion cells, in portable electronics devices. Other low-power microcontrollers are designed to always be powered on and typically include an active mode for processing and a sleep mode for monitoring a signal while drawing a miniscule amount of current.

In Medicals

Many medical devices, such as an insulin pump, are typically controlled by a microprocessor. The microprocessors perform various functions, such as processing data from bio-sensors, storing measurements, and analyzing results.

For these applications, designers often select a microprocessor with a rich instruction set and proven track record, ensuring reliable operation and maximizing the investment in code generation can be leveraged in the next generation medical products. The increasing use of microprocessors and associated software in both implanted and external medical devices poses special analytical challenges. Programmable pacemakers, long-term portable ECG recorders, and ECG arrhythmia detection monitors, for example, contain cardiac arrhythmia detection software. Examination of such devices is difficult, especially because failures are rare and transient. Figure 10.4 presents the state diagram of an emergency medical services (EMS).

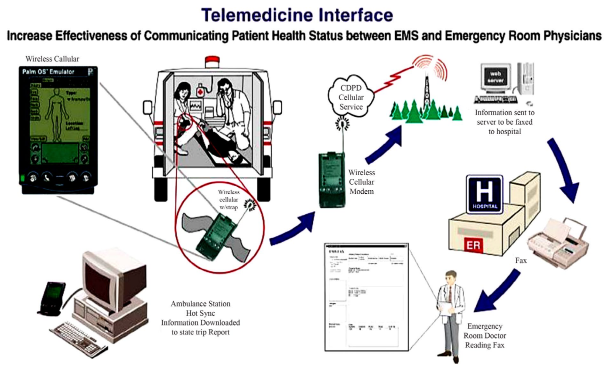


Figure 10.4: Diagram showing EMS state diagram.

Communication

Among the many types of peripheral, circuits that can be built into microcontrollers are communication **interfaces**, and in particular wireless interface circuits. Microcontrollers designed for communication applications include sections for handling communication protocols such as Wi-Fi, Bluetooth, ZigBee, CAN bus, infrared, USB and Ethernet. Communication microcontrollers can be found in wireless devices and in wired network devices such as those in automotive applications. In telephone industry, microprocessors are used in digital telephone sets, telephone exchanges and modem etc. The use of microprocessor in television, satellite communication has made teleconferencing possible. Railway reservation and air reservation system also uses this technology. LAN and WAN for communication of vertical information through computer network.

Keyword

Interface is a shared boundary across which two separate components of a computer system exchange information.

Deep Cover Security Systems

The deep cover secure microcontroller (MAX32590) provides an interoperable, secure, and cost-effective solution to build new generations of trusted devices such as multimedia-enabled portable EFT-POS terminals. The MAX32590 integrates a memory management unit (MMU), 32KB of instruction cache, 16KB of data cache, 4KB instruction TCM, 4KB data TCM, 384KB of system SRAM, 3KB of one-time-programmable (OTP) memory, 128KB of Boot ROM, 24KB of battery-backed SRAM. The MAX32590 maximizes on-chip bandwidth when dealing with high-speed communication such as 100Mbps Ethernet, large color LCD displays, and gigabit-sized mass storage devices. Deep cover embedded security solutions cloak sensitive data under multiple layers of advanced physical security to provide the most secure key storage possible. In addition to hardware crypto functions, the MAX32590 provides a true random number generator, battery-backed RTC, nonvolatile SRAM and real-time environmental and tamper detection circuitry to facilitate system-level security for the application.

Automatic Process Control

A process is a series of actions or tasks that are carried out according to the instructions or program or plan so that a desired result is obtained. For example, raw material is treated by a series of processes so as to get the final product.

The solenoid valves open or close to control flow, and the heating elements go on and off to reach a final temperature in a sequence; the motors control and timers are also used in controlling the process. Process control means a control system in which the states and operations are defined as a function of time and there is a preset sequence in the program. A microcontroller has input ports to receive the bits for the physical parameters, the timer to interrupt at set intervals and inputs. The MCU instructions check the needed actions. The output ports send the control bits to various points for the actions. Microprocessor-based controllers are available in appliances, such as microwave oven, washing machine etc microprocessors are being used in controlling various parameters like speed, pressure, temperature etc. These are used with the help of suitable transduction.

Embedded systems at home

A vast number of modern devices in the home are microprocessor controlled. Examples include: washing machines; camera; calculators; hi-fi systems; telephones; microwave ovens; burglar alarms etc. The input are usually sensors, buttons or simple numeric keyboards while the output include simple LCD screens displays, motors and relays, LEDs, lights, buzzers etc.

Office Automation and Publication

Microprocessor-based systems are used extensively in the workplace, often to automate and monitor production in some way. Examples include: electronic tills, automatic car washes, security systems, FAX and telephone systems, automated production lines, automated warehousing, manufacturing robots etc. Microprocessor based microcomputer with software packages has changed the office environment. Microprocessor-based systems are being used for word processing, spread sheet operations, storage etc. The microprocessor has revolutionized the publication technology.

Instrumentation

Microprocessor is very useful in the field of instrumentation. Frequency counters, function generators, frequency synthesizers, spectrum analyses and many other instruments are available, when microprocessors are used as controller. It is also used in medical instrumentation.

Entertainment

The use of microprocessor in toys, entertainment equipment and home applications is making them more entertaining and full of features. The use of microprocessors is more widespread and popular.

10.3.1 Microcontrollers

Microcontrollers are designed for industrial control applications, where ease of use and versatility rather than speed is the main requirements. They interface with sensors and other devices in applications ranging from on-board computers in cars to lighting systems and renewable energy control systems.

Input/output and memory functions are often embedded along with the core processing functions on one chip. In addition to Intel, Freescale, Micron and Texas Instruments are major manufacturers of microcontrollers. When the most modern technical engineering is applied to a microcontroller it allows the device to be extremely compact, making microcontrollers popular within mobile devices such as cell phones and PDAs.

To the layperson, microcontrollers and microprocessors may seem like very different devices; however, it is important to note that all microcontrollers contain microprocessors. The major difference between a microcontroller and a multifunctional PC microprocessor is the overall level of complexity. Microcontroller processors are designed to fill a smaller, more focused variety of roles while making use of less expensive and less complex circuitry. The main advantage of a microcontroller is that it allows electronic automation in situations where a full-sized computer is not needed. Microcontrollers integrate a microprocessor with peripheral devices for control of embedded system (computer system designed for specific control functions within a larger system, often with real-time computing constraints). Embedded systems range from portable devices such as digital watches, and MP3 players, to large stationary installations like traffic lights, and factory controllers

Microcontrollers shine in situations where limited computing functions are required within an easily definable set of parameters. Microcontrollers excel at the low grade computational functions required to run devices such as electronic parking meters, vending machines, simple sensors and even home security equipment. Microcontrollers surround most Americans in their homes and offices, being present in devices such as televisions, remote controlled stereos and even the digital computer components of a timer on a newer stove.

In real-time computing systems, microprocessors are embedded in security devices such as the anti-lock braking system (ABS) that are widely used in modern automobiles. The microprocessor detects motions and changes, that are relative to the surrounding or environment of the security device and sends signals that correspond to the changes that it detected. Microcontrollers have innumerable applications.

Some examples of their simple applications are in

- Biomedical instruments like an ECG LCD display cum recorder, blood cell recorder cum analyzer, patient monitor system,
- Communication systems like numeric pagers, cellular phones, cable TV terminals, FAX and transceivers with or without an accelerator, video game and so on,
- Peripheral controllers of a computer such as the keyboard controller, printer controller, laser printer controller, LAN controller and disk drive controller
- Instruments such as an industrial process controller, and electronic smart weight display system, (v) a target tracker,
- An automatic signal tracker,
- Accurate control of the speed and position of a DC motor,
- A robotics system,
- A CNC machine controller
- Automotive applications like a close loop engine control, a dynamic ride control, an anti-lock braking system monitor and so on,
- Electronic data acquisition and supervisory control system, the industrial moisture recorder cum controller, CRT display controller, digital storage system and spectrum analyzer.

The microcontrollers are classified in terms of internal bus width, embedded microcontroller, instruction set, memory architecture, IC chip or VLSI core (VHDL or Verilog) file and family. There are 8-bit, 16-bit and 32-bit microcontrollers. For the same family, there may be various versions with various sources. The processors in microcontrollers are either general processors or purpose built.

General Purpose Processors (GPP)

Microprocessors commonly used in general computing tasks include those embedded in laptops or desktop computers. These microprocessors are responsible for the core computing processes, such as calculation and data transfer. General purpose processors are designed for personal computers, laptops, mobile devices and large central servers. Several companies make general purpose processors, including Intel, IBM and Motorola. Companies generally come out with faster and more complex chips every two to three years. Intel is the recognized industry leader in this space. From the earlier Pentium and Centrino microprocessors to the Core 2 and Atom chips for desktop and mobile computers and the high-end Itanium and Xeon processors for server applications, Intel is generally regarded as the company that sets the benchmark for others to follow. The PowerPC microprocessors were co-developed by Motorola, Apple and IBM originally for Apple's Macintosh computers, but Apple switched to Intel chips in 2006. Apple uses other processors as well.

Application-Specific Processors (ASP)

ASPs are specialized to perform one function well. There are three types of ASP. These are the digital-signal processor (DSP), the application-specific integrated circuit (ASIC), and the application-specific instruction set processor (ASIP). DSPs are used for fast numerical computation. ASICs have a particular algorithm implemented directly in their hardware. ASIPs are a halfway house between a GPP and an ASIC. ASIPs have some programmability.

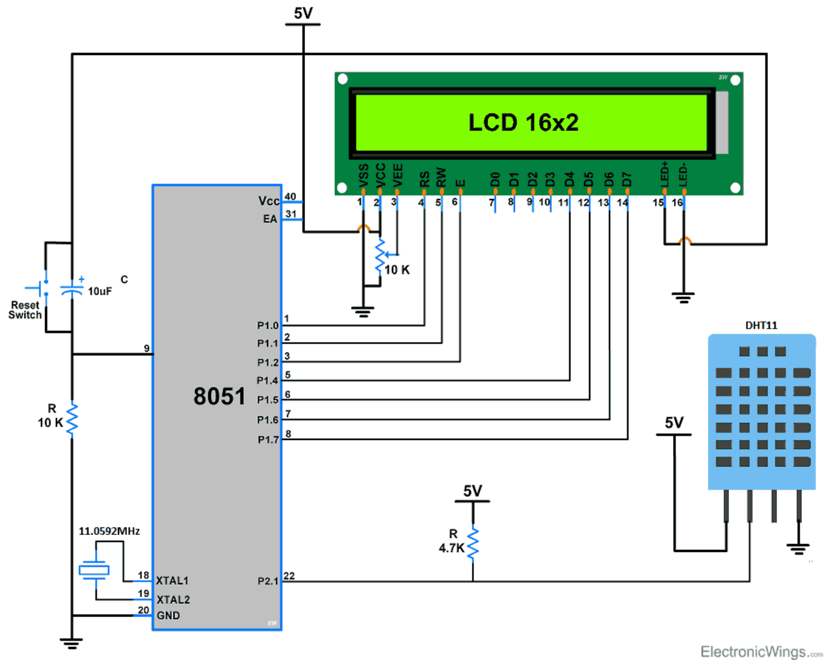
10.3.2 Temperature Controller Using AT89S51

This temperature controller circuit is based on the Microcontroller AT89S51 and the ADC 0804. It demonstrates how analog data is converted in to digital form, so it can be displayed on the LCD. It also covers the sub rooting of microcontroller interface with LCD.

Circuit Diagram

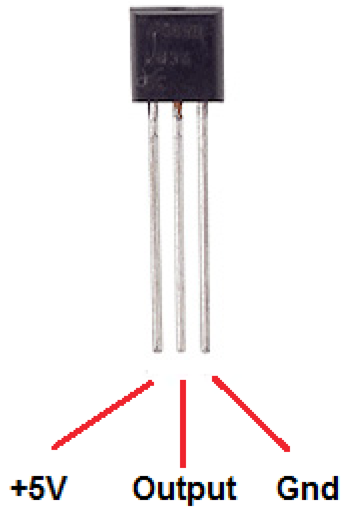
In this project we deal with more than one parameter or physical quantity that is. Temperature and humidity, so instead of using a single channel ADC 0804 we use a multichannel ADC 0809. ADC 0809 is a multichannel ADC which is capable of giving 8 output digital signals of 8 input analog signals. Three channel select lines are provided in order to select the 8 input one at a time. D1 to D8 are the digital data output lines, which is connected to the microcontroller. In this project we deal with more than one parameter or physical quantity that is. Temperature and humidity, so instead of using a single channel ADC 0804 we use a multichannel ADC 0809. ADC

0809 is a multichannel ADC which is capable of giving 8 output digital signals of 8 input analog signals. Three channel select lines are provided in order to select the 8 input one at a time. D1 to D8 are the digital data output lines, which is connected to the microcontroller.

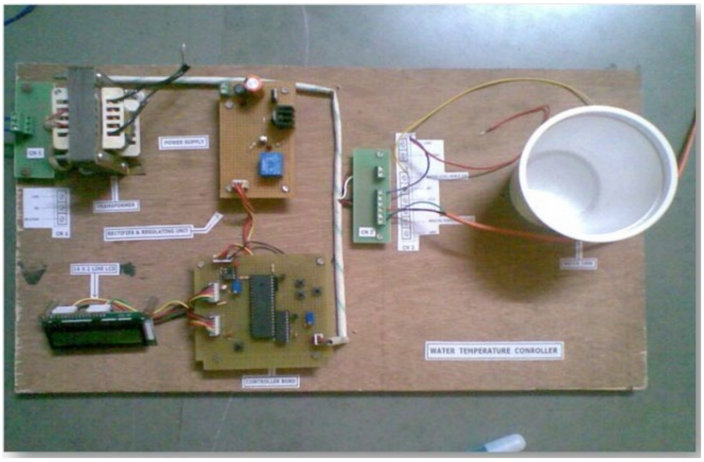


AT89S51 is an 8051 compatible microcontroller from the ATMEL family. ADC0804 is a single channel ADC, in this project it is configured in auto mode that is. It converts the incoming analog signal into the digital form continuously without generating any interrupt. The main-board has provided with three keys for incrementing, decrementing and enters, for setting the cut of point of temperature value

We know that in our atmosphere every physical quantity is in the analog form that is. Continuous varying signals with respect to time, so we have something to convert that analog quantity into the electronic signals so as for electronic use and study, in this way sensor comes into picture. There are n numbers of sensors to sense the physical quantity like Temperature sensor, Humidity sensor, Pressure sensor, Gas sensor etc. We are interested in temperature sensors; one of the most commonly available temperature sensors is the LM35 or LM34 temperature sensor.



The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1/4°C at room temperature and ±3/4°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the water level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package



10.3.3 Stepper Motor Control

Stepper motor is also called steeping motor or step motor. The name steeper is used because this motor rotates through fixed angular step in response to each input current pulse received by the controller. The growing popularity of stepping motors is only due to falling prices; another factor must be that they logically fit into digital thinking. So they can be controlled directly by computers, microprocessors & programmable controllers. Many computer peripherals, such as disk drives, printer and plotters or computer-controlled equipment like XY table and robot limbs, make use of steeping motor. In computer, CPU have a brain but not the (whole) body. Now with the aid of steeping motor they can create an interface between that brain and mobile reality.

This obviates problems often encountered in feedback systems such as instability and overshoot. A stepping motor may therefore replace a conventional D.C. servo system with feedback.

REMEMBER

Stepping motors are electromechanical converters. This type of motor responds in a well-defined way to certain digital signals fed to their control electronics. Stepping motors may therefore be used as an open system that is without feedback for control purposes.

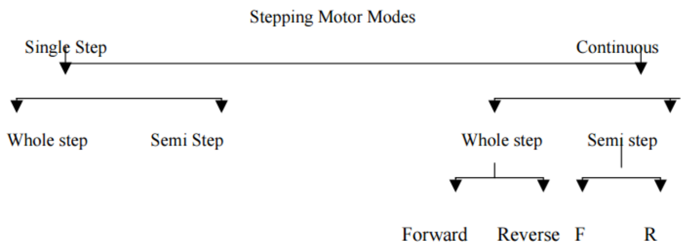
Principle of Operation

A stepping motor may be compared with a synchronous motor as far as operation is concerned: a rotating field, here generated by the control electronics, pulls a magnetic rotor along. Stepping motors are sub divided according to the manner in which the rotating field is generated, that is with unipolar or bipolar stator windings and the material from which the rotor has been constructed – permanent magnetic material or soft iron.

Step angle: The angle through which the motor shaft rotates for each command pulse is called the step angle φ = 360°/No. of stator faze X No of rotor teeth

Smaller the step angle, greater the number of step per revolution and higher the resolution or accuracy of positioning obtained. The angle can be as small as 0.72° or as large as 90°.but the most common step angle 1.8°, 2.5°, 7.5°, 15°

Unipolar and bipolar stepping motor can be operated in following modes



A bipolar stepping motor with a permanent magnetic rotor is shown in Figure 10.5.

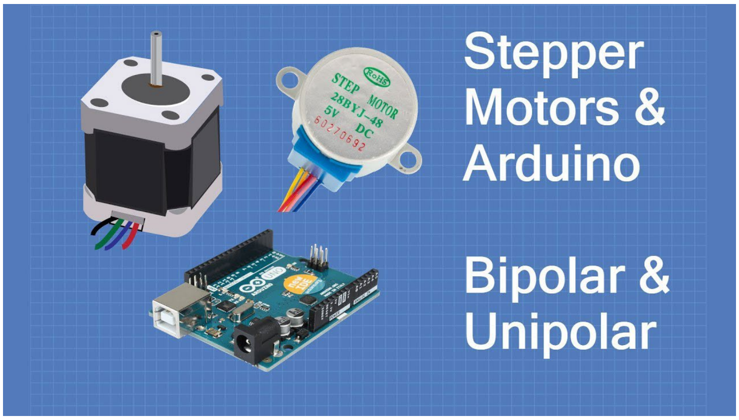


Figure 10.5: Bipolar stepping motor.

At the onset, both windings carry a current the stator is magnetized correspondingly, and the rotor has oriented itself accordingly. If the polarity of the current in A is reversed the field shifts 90° anticlockwise and pulls the rotor along. The sequence of activation for a complete revolution is AB-A′B-A′B′-AB′-AB that is four steps 90° each. So digital sequences are applied to power driver in binary values 10011001, 01101001, 01100110, 10010110. The sequence then becomes: AB-B-A′B-A′-A′B′-B′-AB′-A-AB. In this semi step operation, the steps are smaller but the moment is less regular and, on average, smaller because during half the time only one half of the number of phases is being used.

Unipolar stepping motors look the same as bipolar ones, but they are wound differently. Each phase now consists of a winding with a center tap or two separate windings, so that the magnetic field can be inverted without the necessity of changing the direction of the current. A unipolar stepping motor with a permanent magnetic rotor is shown in Figure 10.6.

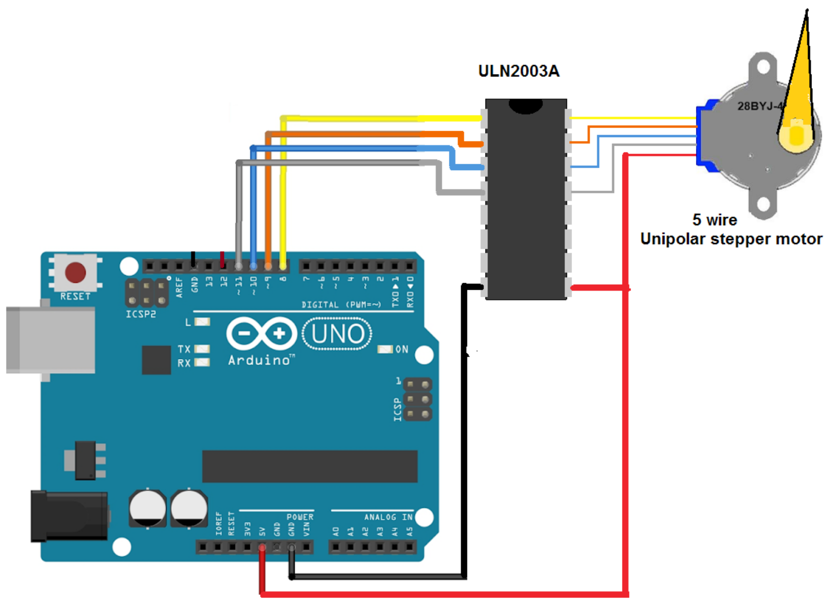


Figure 10.6: A unipolar stepping motor.

At the onset, both windings carry a current the stator is magnetized correspondingly, and the rotor has oriented itself accordingly. If the polarity of the current in A is reversed the field shifts 90° anticlockwise and pulls the rotor along. The sequence of activation for a complete revolution is AB-A′B-A′B′-AB′-AB that is four steps 90° each. So digital sequences are applied to power driver in binary values 1010, 0110, 0101, 1001.These digital sequences in hexadecimal format in shown in tables 10.3 and 10.5. It is also possible before reversing the polarity in a phase, to switch off the current to that winding. The sequence then becomes: AB-B-A′B-A′-A′B′-B′-AB′-A-AB. In this semi step operation, the steps are smaller but the moment is less regular and, on average, smaller because during half the time only one half of the number of phases is being used. Here in tables 10.4 and 10.6 represents the equivalent hexadecimal values they are 0A, 02,06,04,05,01,09,08.

If unipolar windings are to be housed in the same space as one Bipolar winding, it is evident that either fewer turns per winding, or thinner wire must be used. In either case, the result is fewer ampere-turns and consequently a weaker magnetic field .A unipolar stepping motor, therefore has a smaller moment than a bipolar one of the same dimensions. The maximum stepping rate is limited because the permanent magnet rotor causes an inductive voltage in the stator. Motors with relatively high rotating speeds, therefore often use soft iron rotors that have fewer poles than the stator, which is always unipolar

Stepper motor controllers consists of logic sequencer, power driver. Logic sequencer provides digital sequences to power driver. Power driver increase the power level of the digital data and energies the windings of stepper motor. Logic sequences can be generated by microprocessor or Logic sequencer.

Table 10.1: Whole Step (Uni)

1	2	3	4	HEX
1	0	0	1	09
1	0	1	0	0A

Table 10.2: Semi step (Uni)

1	2	3	4	HEX
1	0	0	1	09
1	0	0	0	08

Table 10.3: Continue (Unit)

1	2	3	4	HEX
1	0	1	0	0A
0	1	1	0	06
0	1	0	1	05
1	0	0	1	09

Table 10.4: Semi Conti (Unit)

1	2	3	4	HEX
1	0	1	0	0A
0	0	1	0	02
0	1	1	0	06
0	1	0	0	04
0	1	0	1	05
0	0	0	1	01
1	0	0	1	09
1	1	0	0	08

Table 10.5: whole step (Bi)

1	2	3	4	5	6	7	8	HEX
1	0	0	1	1	0	0	1	99
0	1	1	0	1	0	0	1	69

Table 10.6: semi step (Bi)

1	2	3	4	5	6	7	8	HEX
1	0	0	1	0	1	1	0	96
0	0	0	0	0	1	1	0	06

Table 10.7: Continue (Bi)

1	2	3	4	5	6	7	8	HEX
1	0	0	1	1	0	0	1	99
0	1	1	0	1	0	0	1	69
0	1	1	0	0	1	1	0	66
1	0	0	1	0	1	1	0	96

Table 10.8: Semi continue (Bi)

1	2	3	4	5	6	7	8	HEX
1	0	0	1	1	0	0	1	99
0	0	0	0	1	0	0	1	09
0	1	1	0	1	0	0	1	69
0	1	1	0	0	0	0	0	60
0	1	1	0	0	1	1	0	66
0	0	0	0	0	1	1	0	06
1	0	0	1	0	1	1	0	96
1	0	0	1	0	0	0	0	90

We designed logic sequencer using EPROM (2732), 555 timer, counter (7493), and NAND gates. Digital sequences in table 10.1 to 10.8 are stored in EPROM using microprocessor.555 timer provides CLK signal to the counter. Counter's four output lines are connected to A0 to A4 address lines of EPROM. Four switches are connected to A4 to A7. So desire mode can be selected by switches S1 to S4.Each mode has 16 locations in EPROM, corresponding digital sequence are stored in it. To automatically reset the counter, there is 00H store at the end of each table. Counter will automatically reset using NAND gates when all bits are zero so stepper motor can be run in selected mode until we change the switch position. Speed of motor can be controlled by varying the CLK frequency. It provides f range from 1 to 100 Hz.

A7	A6	A5	A4	A3	A2	A1	A0
Bipolar (0)/ unipolar (1)	Whole (0)/ step (1)	Step (0)/ Continue (1)	Forward (0) /reverse (1)	Counter			

Power Drivers

The signals produced by the logic sequencer are so weak that they are unable to energies the motor windings. We have, therefore, got to use power drivers to raise the power level sufficiently to energies the motor windings. Power drivers are made up of power transistor or thyristors, depending on the required power level. It is possible to use only two transistors per winding, but a symmetrical power supply is then required. In stepper motor, due to finite winding inductance, phase current cannot be switched off instantaneously. If the base drive of the switching transistor were suddenly removed a large induced voltage would appear between transistor collector and emitter, causing permanent damage to the drive circuit. These possibilities are avoided by providing an alternative current path known as the freewheeling circuit for the phase current. When the switching transistor is turned off the phase current continue to flow through path provided by the freewheeling diode and freewheeling resistance

Application

Stepper motor uses for operation control in computer peripherals, textile industry, IC fabrication and robotics etc. Incremental motion of typewriters, line printers, tape drives, floppy disk drives, NC machine tools, process control system and X-Y Plotters etc. are also controlled by the same. Stepper motors also performs lot of task outside the computer industries. It includes commercial, military and medical application where this motor performs such functions as mixing, cutting, striking, metering, blending and purging. They also take part in the manufacturing of packed foodstuffs, commercial end products and even the production of science fiction movies

SUMMARY

- A microprocessor is a computer processor wherein the data processing logic and control is included on a single integrated circuit, or a small number of integrated circuits. The microprocessor contains the arithmetic, logic, and control circuitry required to perform the functions of a computer's central processing unit.
- A microprocessors is simply a computer processor that has been configured into the design and function of a microchip. Sometimes referred to as a logic chip, this small component functions as the means of executing the command to start booting up a computer.
- A Microprocessor is an important part of a computer architecture without which you will not be able to perform anything on your computer. It is a programmable device that takes in input performs some arithmetic and logical operations over it and produces the desired output
- A Microprocessor takes a bunch of instructions in machine language and executes them, telling the processor what it has to do.
- RISC stands for Reduced Instruction Set Computer. It is designed to reduce the execution time by simplifying the instruction set of the computer. Using RISC processors, each instruction requires only one clock cycle to execute results in uniform execution time.
- CISC stands for Complex Instruction Set Computer. It is designed to minimize the number of instructions per program, ignoring the number of cycles per instruction. The emphasis is on building complex instructions directly into the hardware.
- A transputer is a specially designed microprocessor with its own local memory and having links to connect one transputer to another transputer for inter-processor communications. It was first designed in 1980 by Inmos and is targeted to the utilization of VLSI technology.
- Microprocessor is a program-controlled device, which fetches the instructions from memory, decodes and executes the instructions. Most microprocessor are single- chip devices. The functional block diagram or architecture of 8085 microprocessor, gives the complete details about the internal microprocessor.
- The control bus consists of 4-10 parallel signal lines. The CPU sends out signals on the control bus to enable the outputs of addressed memory devices or port devices.
- Program Counter (PC) is 16-bit register sequencing the execution of instructions in memory that why it is also called as memory pointer. The function of the program counter is to point out the memory address of the next instruction which is to be executed.

- Instruction register is 8-bit register just like every other register of microprocessor. The instruction may be anything like adding two data's, moving a data, copying a data etc.
- Microprocessor has 16 bit address bus. The bus over which the CPU sends out the address of the memory location is known as Address bus. The address bus carries the address of memory location to be written or to be read from.
- The control bus is used for sending control signals to the memory and I/O devices. The CPU sends control signal on the control bus to enable the outputs of addressed memory devices or I/O port devices.
- Address bus is a part of the computer system bus that is dedicated for specifying a physical address. When the computer processor needs to read or write from or to the memory, it uses the address bus to specify the physical address of the individual memory block it needs to access (the actual data is sent along the data bus).
- Microcomputers are much smaller computer. They operate still more slowly and they work with still smaller data words (typically 4 bits, 8 bits, 16 bits or 32 bits).
- A microprocessor is usually a silicon chip that contains millions of transistors and other components that process millions of instructions per second integrated with memory chips and other special purpose chips, and directed by software.
- Microprocessors work behind the scenes to keep commuters safe and timely. Consumer vehicles-cars, trucks, RVs- integrate microprocessors to communicate important information throughout the vehicle.
- The brain of the computer is microprocessor-drives technology. They are used in computer ranging from microcomputers to supercomputers. In addition, many electronic devices have central processing units (CPU) embedded.

KNOWLEDGE CHECK

1. **What is true about microprocessor?**
    a. Microprocessor is a controlling unit of a micro-computer
    b. It is fabricated on a small chip capable of performing ALU (Arithmetic Logical Unit) operations
    c. It also communicate with the other devices connected to it.
    d. All of the above
2. **Microprocessor consists of?**
    a. ALU
    b. register array
    c. control unit
    d. All of the above
3. **The __________ controls the flow of data and instructions within the computer.**
    a. control unit
    b. register array
    c. accumulator
    d. ALU
4. **Which of the following is not a features of a Microprocessor?**
    a. Versatility
    b. Reliability
    c. Low Bandwidth
    d. Low Power Consumption
5. **The microprocessor ___________ those instructions from the memory**
    a. Fetch
    c. Decode
    d. Execute
    d. None of the above
6. **It determines the number of operations per second?**
    a. Bandwidth
    b. Word Length
    c. Clock Speed
    d. Operations Speed

7. Clock Speed is also known as?

a. Clock Rate.

b. Clock Length.

c. Clock Set.

d. Clock Type.

8. An 8-bit microprocessor can process _____ data at a time.

a. 4-bit

b. 8-bit

c. 16-bit

d. All of the above

REVIEW QUESTIONS

1. What are the basics of microprocessor?
2. Explain the various generations of microprocessor.
3. Illustrate the bus structure of 8085 microprocessor.
4. Give an overview on microcontrollers.
5. Define the features of multiplexing address and data bus.

Check Your Results

1. (d)	2. (d)	3. (a)	4. (c)
5. (a)	6. (c)	7. (a)	8. (b)

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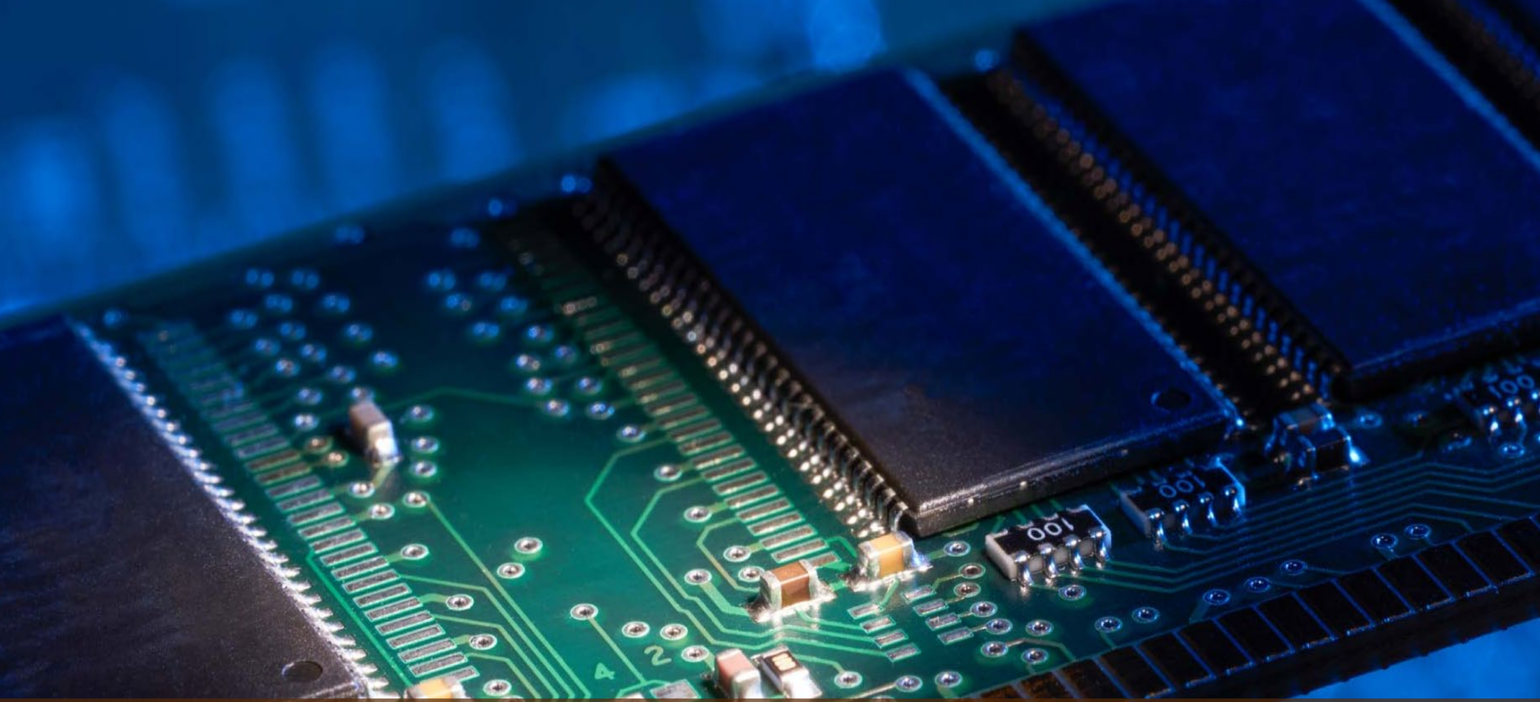


CHAPTER 11

COMPUTER MEMORY MANAGEMENT

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Define the fundamental of memory management
2. Fix the memory management error
3. Access the memory management in operating system
5. Prepare for implementation of all partition allocation methods in memory management

> *"In computer animation, every detail has to be thought out, designed, modeled, shaded, placed and lit. The more you add, the more computer memory you need."*
>
> *—John Lasseter*

INTRODUCTION

Memory management is the process of controlling and coordinating computer memory, assigning portions called blocks to various running programs to optimize overall system performance. Memory management resides in hardware, in the OS (operating system), and in programs and applications.

In hardware, memory management involves components that physically store data, such as RAM (random access memory) chips, memory caches, and flash-based SSDs (solid-state drives). In the OS, memory management involves the allocation (and constant reallocation) of specific memory blocks to individual programs as user demands change. At the application level, memory management ensures the availability of adequate memory for the objects and data structures of each running program at all times. Application memory management combines two related tasks, known as allocation and recycling.

When the program requests a block of memory, a part of the memory manager called the allocator assigns that block to the program.

When a program no longer needs the data in previously allocated memory blocks, those blocks become available for reassignment. This task can be done manually (by the programmer) or automatically (by the memory manager).

11.1 FUNDAMENTAL OF MEMORY MANAGEMENT

Memory Management is the process of controlling and coordinating computer memory, assigning portions known as blocks to various running programs to optimize the overall performance of the system.

It is the most important function of an operating system that manages primary memory. It helps processes to move back and forward between the main memory and execution disk. It helps OS to keep track of every memory location, irrespective of whether it is allocated to some process or it remains free.

Here, are reasons for using memory management:

- It allows you to check how much memory needs to be allocated to processes that decide which processor should get memory at what time.
- Tracks whenever inventory gets freed or unallocated. According to it will update the status.
- It allocates the space to application routines.
- It also make sure that these applications do not interfere with each other.
- Helps protect different processes from each other
- It places the programs in memory so that memory is utilized to its full extent.

Memory management is a form of resource management applied to computer memory. The essential requirement of memory management is to provide ways to dynamically allocate portions of memory to programs at their request, and free it for reuse when no longer needed. This is critical to any advanced computer system where more than a single process might be underway at any time.

Several methods have been devised that increase the effectiveness of memory management. Virtual memory systems separate the memory addresses used by a process from actual physical addresses, allowing separation of processes and increasing the size of the virtual address space beyond the available amount of RAM using paging or swapping to secondary storage. The quality of the virtual memory manager can have an extensive effect on overall system performance.

11.1.1 Memory Management Techniques

Here, are some most crucial memory management techniques:

Single Contiguous Allocation: It is the easiest memory management technique. In this method, all types of computer's memory except a small portion which is reserved for the OS is available for one application. For example, MS-DOS operating system allocates memory in this way. An embedded system also runs on a single application.

Partitioned Allocation: It divides primary memory into various memory partitions, which is mostly contiguous areas of memory. Every partition stores all the information for a specific task or job. This method consists of allotting a partition to a job when it starts & unallocated when it ends.

Paged Memory Management: This method divides the computer's main memory into fixed-size units known as page frames. This hardware memory management unit maps pages into frames which should be allocated on a page basis.

Segmented Memory Management: Segmented memory is the only memory management method that does not provide the user's program with a linear and contiguous address space.

Segments need hardware support in the form of a segment table. It contains the physical address of the section in memory, size, and other data like access protection bits and status.

11.1.2 Implementation of Contiguous Memory Management Techniques

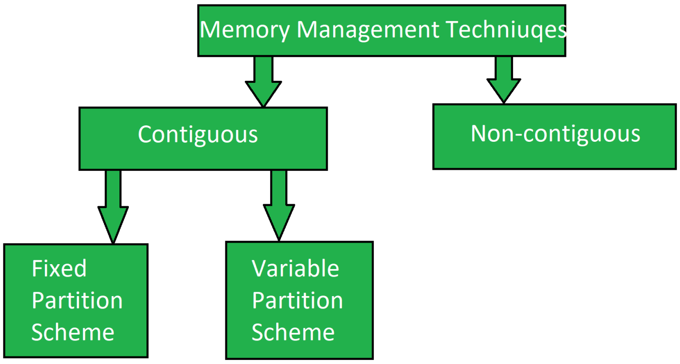
Memory Management Techniques are basic techniques that are used in managing the memory in operating system. Memory Management Techniques are basically classified into two categories:

(i) Contiguous

(ii) Non-contiguous

Contiguous Memory Management Techniques:

In this technique, memory is allotted in a continuous way to the processes. It has two types:

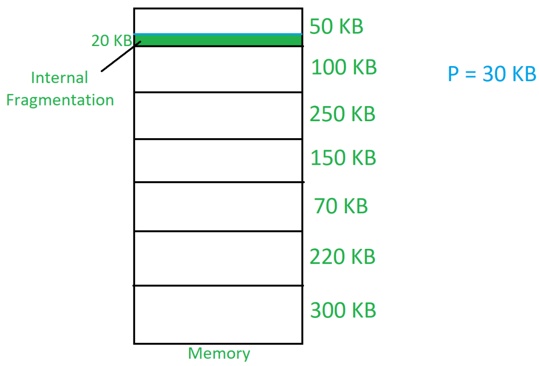


Fixed Partition Scheme:

In the fixed partition scheme, memory is divided into fixed number of partitions. Fixed means number of partitions are fixed in the memory. In the fixed partition, in every partition only one process will be accommodated. Degree of multi-programming is restricted by number of partitions in the memory. Maximum size of the process is restricted by maximum size of the partition. Every partition is associated with the limit registers.

Limit Registers: It has two limit:

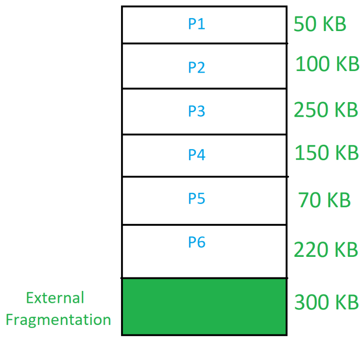
- Lower Limit: Starting address of the partition.
- Upper Limit: Ending address of the partition.



Internal Fragmentation is found in fixed partition scheme. To overcome the problem of internal fragmentation, instead of fixed partition scheme, variable partition scheme is used.

Variable Partition Scheme:

In the variable partition scheme, initially memory will be single continuous free block. Whenever the request by the process arrives, accordingly partition will be made in the memory. If the smaller processes keep on coming then the larger partitions will be made into smaller partitions.



External Fragmentation is found in variable partition scheme.

To overcome the problem of external fragmentation, compaction technique is used or non-contiguous memory management techniques are used.

Compaction

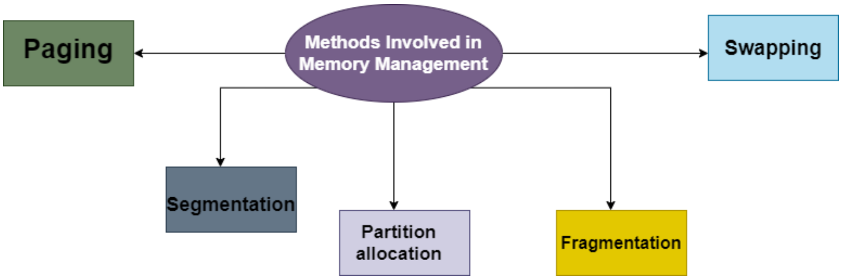
Moving all the processes toward the top or towards the bottom to make free available memory in a single continuous place is called as compaction. Compaction is undesirable to implement because it interrupts all the running processes in the memory.

11.1.3 Methods Involved in Memory Management

There are various methods and with their help Memory Management can be done intelligently by the Operating System:

Keyword

Internal fragmentation is what this garbage is termed. Unlike many other forms of fragmentation, it is impossible to restore inner fragmentation, typically, the only way to eliminate it is with a new design.



Swapping in OS

A process needs to be in memory for execution. But sometimes there is not enough main memory to hold all the currently active processes in a timesharing system. So, the excess process is kept on disk and brought in to run dynamically. Swapping is the process of bringing in each process in the main memory, running it for a while, and then putting it back to the disk.

Contiguous Memory Allocation

In contiguous memory allocation, each process is contained in a single contiguous block of memory. Memory is divided into several fixed-size partitions. Each partition contains exactly one process. When a partition is free, a process is selected from the input queue and loaded into it. The free blocks of memory are known as holes. The set of holes is searched to determine which hole is best to allocate.

Memory Protection

Memory protection is a phenomenon by which we control memory access rights on a computer. The main aim of it is to prevent a process from accessing memory that has not been allocated to it. Hence prevents a bug within a process from affecting other processes, or the **operating system** itself, and instead results in a segmentation fault or storage violation exception being sent to the disturbing process, generally killing of process.

Memory Allocation in OS

Memory allocation is a process by which computer programs are assigned memory or space. It is of three types:

- First Fit Allocation. The first hole that is big enough is allocated to the program.
- Best Fit Allocation. The smallest hole that is big enough is allocated to the program.

- Worst Fit Allocation. The largest hole that is big enough is allocated to the program.

Fragmentation in OS

Fragmentation occurs in a dynamic memory allocation system when most of the free blocks are too small to satisfy any request. It is generally termed as the inability to use the available memory.

In such a situation, processes are loaded and removed from the memory. As a result of this, free holes exist to satisfy a request but are non-contiguous i.e. the memory is fragmented into large no. Of small holes. This phenomenon is known as External Fragmentation.

Also, at times the physical memory is broken into fixed-size blocks, and memory is allocated in the unit of block sizes. The memory allocated to space may be slightly larger than the requested memory. The difference between allocated and required memory is known as Internal fragmentation i.e. the memory that is internal to a partition but is of no use.

Paging

A solution to the fragmentation problem is Paging. Paging is a memory management mechanism that allows the physical address space of a process to be non-contagious. Here physical memory is divided into blocks of equal size called Pages. The pages belonging to a certain process are loaded into available memory frames.

Page Table

A Page Table is the data structure used by a virtual memory system in a computer operating system to store the mapping between the virtual address and physical addresses.

The virtual address is also known as the Logical address and is generated by the CPU. While Physical address is the address that actually exists on memory.

Segmentation in OS

Segmentation is another memory management scheme that supports the user-view of memory. Segmentation allows the breaking of the virtual address space of a single process into segments that may be placed in non-contiguous areas of physical memory.

Segmentation with Paging

Both paging and segmentation have their advantages and disadvantages, it is better to combine these two schemes to improve on each. The combined scheme is known as 'Page the Elements'. Each segment in this scheme is divided into pages and each segment is maintained in a page table. So the logical address is divided into the following 3 parts:

- Segment numbers(S)
- Page number (P)
- The displacement or offset number (D)

11.1.4 Parameters in Memory Management

Memory management is one of the more complex parts of system troubleshooting, as it involves a certain degree of guesswork and estimation. Still, you can achieve good results by monitoring the tunables and adjusting them to match your scenario. This means being familiar with the meaning of available parameters and their associated values.

- Dirty_background_bytes – Contains the amount of dirty memory threshold value at which the kernel will start writing dirty pages to the permanent storage. This will be done by background kernel threads (known as pdflush). Why is this useful? For instance, you may see pdflush processes using a very high percentage of CPU, hogging the resources. This could be an indicator of a wider problem. In some situations, you may have the freedom to change the dirty parameters and check whether the issue temporarily goes away.
- Dirty_background_ratio – This parameter is the percentage of total available memory at which the kernel will start writing dirty data. On high-memory machines, this could translate into tens of gigabytes of pages.
- Dirty_bytes – To complicate things a little, this tunable contains the amount of dirty memory at which the flushing will be triggered. It is mutually exclusive of dirty_ratio, and one or the other will be zero (unused).
- Dirty_expire_centisecs – This tunable defines the age of dirty data that can be flushed in hundredths of a second. Pages that have been stored in the memory for longer than the specified interval will be written to disk.
- Dirty_ratio – The percentage threshold at which the process generating disk writes will start writing out dirty data. Again, on systems with large memory, the percentage can translate into a significant amount.
- Dirty_writeback_centisecs – This tunable specifies the interval for the kernel flusher threads to wake and write dirty data to disk.

It becomes apparent that the disk writing policy is a nontrivial mask combining different values set in these variables. However, being aware of their power can help, especially when troubleshooting performance or optimizing systems.

- Drop_caches – When set, this tunable tells the kernel to begin dropping caches. It can accept a limited set of integers, namely, 1 (pagecache), 2 (slab objects), or 3 (both). The operation is nondestructive, and no data will be lost by running it. However, the purpose of this tunable may seem questionable. Why would anyone want to interfere with the normal way the kernel manages its memory?

Again, we go back to the question of performance troubleshooting and optimization. It may be useful to drop caches to time system operations by making sure no object is retrieved from memory, which is essentially a fast operation, but rather from the intended storage, like a network file system or local disk. Furthermore, if the host is exhibiting abnormal operation (possibly due to a bug) with very large caches, dropping them and observing the behavior may confirm the suspicion. However, do note that dropping caches can take a very long time, because it might essentially mean tens or hundreds of megabytes (or even gigabytes) worth of data being written to disk, causing a temporary I/O and CPU load.

Swappiness – This is another useful tunable, which defines how aggressively the kernel swaps memory pages to swap devices (if present). The values range from 0 to 100, with 100 being the most aggressive routine. The default value will vary between distributions and kernel versions. It is important in that it can affect interactive responsiveness and performance, and the number may have to be tweaked to match the hardware, including the size of physical memory, as well as the usage model.

11.2 FIX THE MEMORY MANAGEMENT ERROR

"Memory Management" is one of the most unhelpful phrases that Microsoft suggests you search for if you run into a BSOD (Blue Screen of Death) error while running Windows 10.

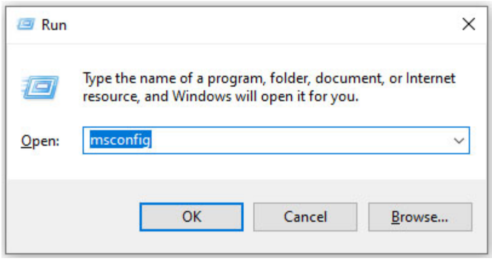
The first step in fixing any computer problem is isolating the issue's source, so you know what to fix. With Window's ominous errors, such as this one, it may be challenging to know where to begin.

Basic troubleshooting is essential to finding your memory management error. Let's take a look at what you can do to get this fixed.

11.2.1 Run Windows 10 in Safe Mode

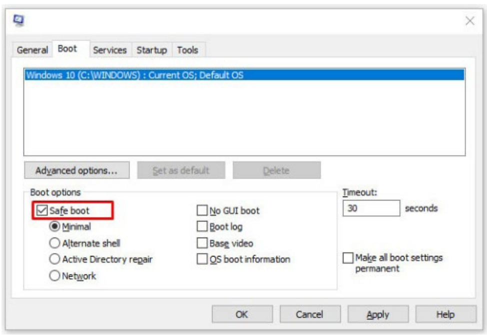
The first thing you should do is launch Windows 10 in safe mode with basic drivers. This action allows you to check whether you still receive the BSOD Memory Management error. Essentially, this shuts down any processes the computer doesn't need. If the memory management error ceases, you'll know it isn't hardware but rather something in the software, such as a patch in an update or a driver. If the problem still occurs, you may need to replace some faulty hardware. To boot your system in Safe Mode, follow the steps below.

- Use the Win+R keyboard shortcut and type *msconfig*, then hit ***enter.***

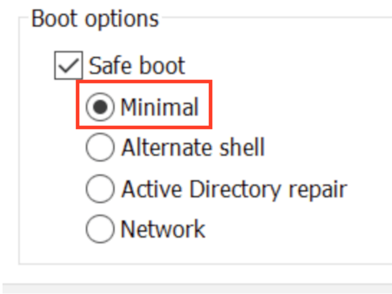


- Tap the *Boot* tab in the upper section of the screen.

- Select *Safe Boot.*



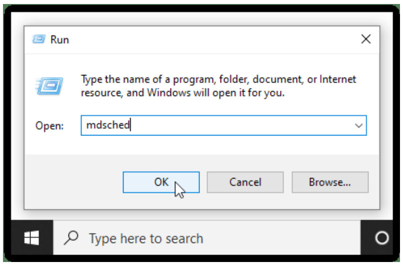
- Choose Minimal from the list of boot options.



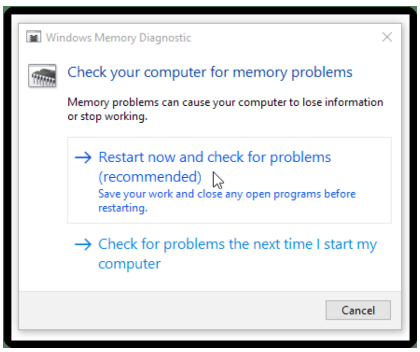
11.2.2 Run Windows Memory Diagnostic

The Windows Memory Diagnostic tool will test your SDRAM and report any problems it finds—if any at all. This step should use Safe Mode to prevent the BSOD issues you experience. However, this requirement is after affirming that your PC worked correctly in Safe Mode using Step 1 above.

- Press the Windows + R keyboard combination and type mdsched, then press ***Enter*** or click ***OK.***

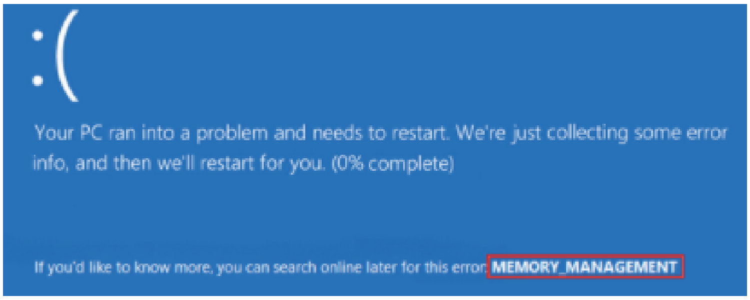


1. Select the option to Restart now and check for problems and run a check for SDRAM problems.



Upon restart, you will receive a report letting you know if you're having a memory issue.

As the name suggests, the memory management error relates to the computer's memory, which can be a physical problem with the installed RAM. The Windows Memory Diagnostic Tool can help discover if this is the root of the problem.



REMEMBER

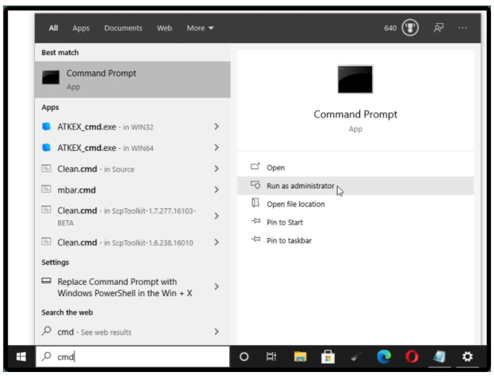
The default 32-bit Windows Operating System (OS) configuration provides up to 4 GB (2^32) of addressable memory space divided equally between the kernel and the user applications. With 4 GB of physical memory available, 2 GB will be allocated to the kernel and 2 GB to application memory.

When Windows restarts, it will tell you if there is something wrong with your memory. If there is, then you'll have to either replace the RAM yourself or send back your computer if it's under warranty.

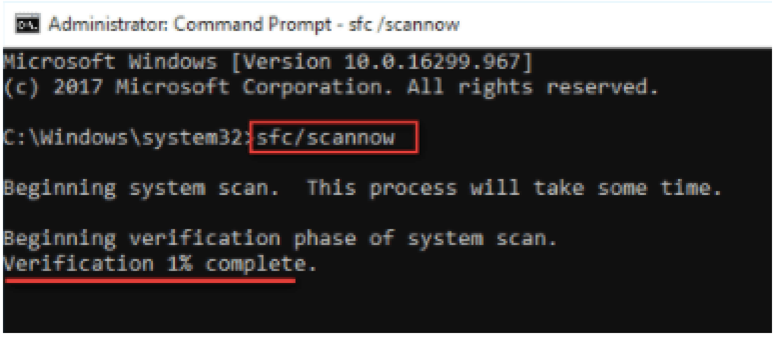
11.2.3 Run SFC Scanner

SFC Scanner is a Microsoft tool for detecting various problems with your system, and running it seems to have solved some people's memory management woes. Once again, this step should also be performed in Safe Mode like Step 1 and Step 2 above.

- In the Cortana search bar, type cmd, then click on Run as administrator in the right panel for the Command Prompt. You can't use the right-click Start Menu option anymore since Powershell replaced Command Prompt.



- Once the Command Prompt opens, type sfc/scannow without quotes and press Enter



SFC Scanner will now run through your system, seeing if it finds any disk errors to fix. Even if it doesn't find anything, some users have found that their computers play nicer after a full scan.

It is best to perform two or three rounds of scanning since the process doesn't always detect anything on the first attempt or fixes something else and needs to find more issues.

11.2.4 Look for Software Problems

Software problems are a little more challenging to pin down. Still, if the memory management error is a relatively new phenomenon, you could try undoing some of your recent software installations to see if it fixes the problem.

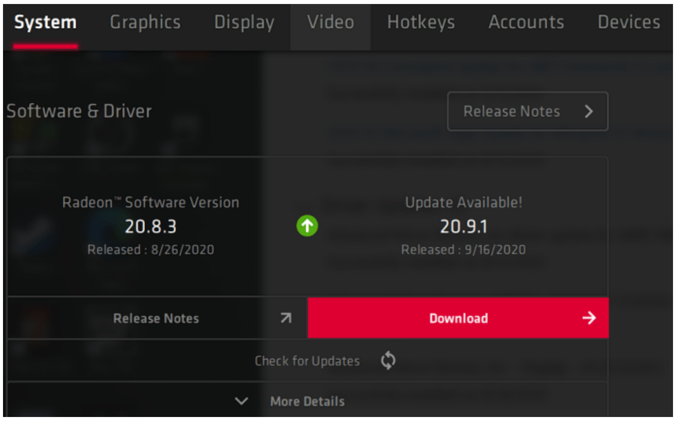
Specific pieces of software often link to memory management errors. You can try disabling and re-enabling newer software to see if that fixes the BSOD, or you can reload Windows 10 entirely (although this is a nuclear option).

Isolating and correcting a software issue or even a corrupted file can take a while, but it's certainly worth it if you're not entirely sure you're experiencing a hardware failure.

11.2.5 Update Your Graphics Card Drivers

One of the most common causes of the memory management error in Windows 10 is outdated or broken graphics card drivers. This scenario makes sense, especially since the graphics card has memory too. If you're not running the latest version, try installing the newest available.

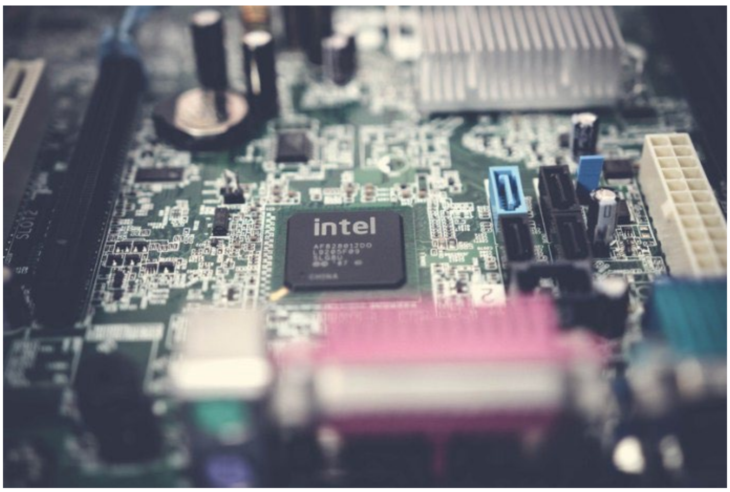
If you already have the latest drivers, try the "uninstall/reinstall" method. Sometimes, a driver is broken or corrupt but goes undetected. The drivers you need will depend on your graphics card, of course. Windows 10 will be able to tell you what you have in your system, but it's likely to be onboard Intel graphics or something from Nvidia or AMD. External video cards have more memory than onboard graphics, and they are more prone to overheating.



Visit the website of the manufacturer and download any updates to get your system working correctly again.

11.2.6 Upgrade Your PC's Hardware

Depending on the results of your troubleshooting adventures, it may be time to upgrade some of your system's hardware. As software and PC technology progress, so does hardware requirements.



Before rushing out to buy new hardware, check to ensure that everything in the case is seated correctly. Perhaps you recently moved your machine, and something came loose, or your hardware could use a thorough cleaning.

If it's a machine that you've built or one that is out-of-warranty, it's time to look for new components to get your computer up and running again. It may be an opportunity for a new graphics card, or you may need more RAM. Whatever the case, if you've tried everything above and the issue persists, it's likely hardware-related.

11.3 MEMORY MANAGEMENT IN OPERATING SYSTEM

The term Memory can be defined as a collection of data in a specific format. It is used to store instructions and processed data. The memory comprises a large array or group of words or bytes, each with its own location. The primary motive of a computer system is to execute programs. These programs, along with the information they access, should be in the main memory during execution. The CPU fetches instructions from memory according to the value of the program counter.

To achieve a degree of multiprogramming and proper utilization of memory, memory management is important. Many memory management methods exist, reflecting various approaches, and the effectiveness of each algorithm depends on the situation.

Keyword

Random Access Memory is the hardware in a computing device where the operating system (OS), application programs and data in current use are kept so they can be quickly reached by the device's processor.

11.3.1 Main Memory

The main memory is central to the operation of a modern computer. Main Memory is a large array of words or bytes, ranging in size from hundreds of thousands to billions. Main memory is a repository of rapidly available information shared by the CPU and I/O devices. Main memory is the place where programs and information are kept when the processor is effectively utilizing them. Main memory is associated with the processor, so moving instructions and information into and out of the processor is extremely fast. Main memory is also known as RAM (**Random Access Memory**). This memory is a volatile memory. RAM lost its data when a power interruption occurs.

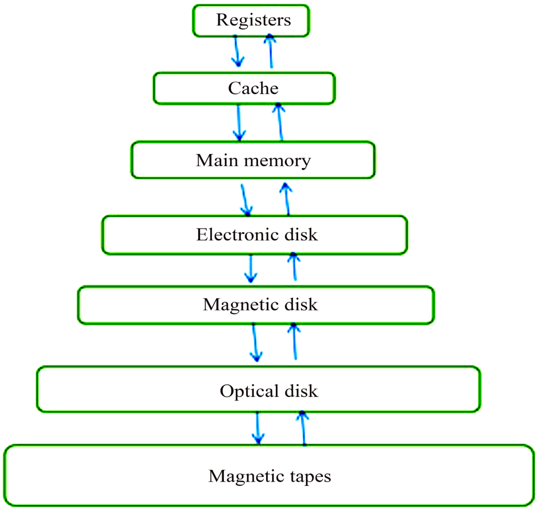


Figure 11.1 Memory hierarchy.

In a multiprogramming computer, the operating system resides in a part of memory and the rest is used by multiple processes. The task of subdividing the memory among different processes is called memory management. Memory management is a method in the operating system to manage operations between main memory and disk during process execution. The main aim of memory management is to achieve efficient utilization of memory.

Why Memory Management is required:

- Allocate and de-allocate memory before and after process execution.
- To keep track of used memory space by processes.
- To minimize fragmentation issues.
- To proper utilization of main memory.
- To maintain data integrity while executing of process.

11.3.2 Logical and Physical Address Space

Logical Address space: An address generated by the CPU is known as "Logical Address". It is also known as a Virtual address. Logical address space can be defined as the size of the process. A logical address can be changed.

Physical Address space: An address seen by the memory unit (i.e. the one loaded into the memory address register of the memory) is commonly known as a "Physical Address". A Physical address is also known as a Real address. The set of all physical addresses corresponding to these logical addresses is known as Physical address space. A physical address is computed by MMU. The run-time mapping from virtual to physical addresses is done by a hardware device Memory Management Unit (MMU). The physical address always remains constant.

11.3.3 Static and Dynamic Loading

To load a process into the main memory is done by a loader. There are two different types of loading:

- **Static loading**:- In static loading load the entire program into a fixed address. It requires more memory space.
- **Dynamic loading**:- The entire program and all data of a process must be in physical memory for the process to execute. So, the size of a process is limited to the size of physical memory. To gain proper memory utilization, dynamic loading is used. In dynamic loading, a routine is not loaded until it is called. All routines are residing on disk in a relocatable load format. One of the advantages of dynamic loading is that unused routine is never loaded. This loading is useful when a large amount of code is needed to handle it efficiently.

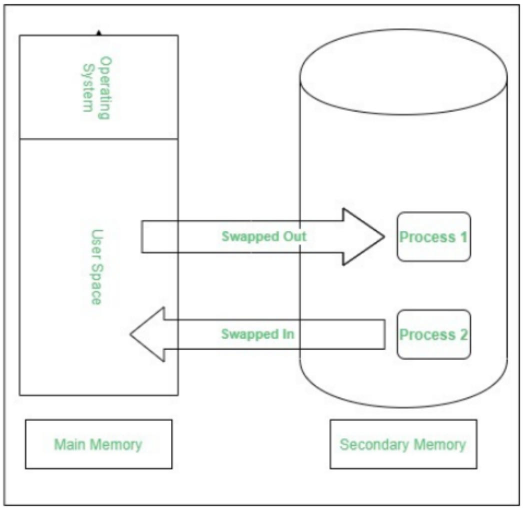
11.3.4 Static and Dynamic linking:

To perform a linking task a linker is used. A linker is a program that takes one or more object files generated by a compiler and combines them into a single executable file.

- **Static linking:** In static linking, the linker combines all necessary program modules into a single executable program. So there is no runtime dependency. Some operating systems support only static linking, in which system language libraries are treated like any other object module.
- **Dynamic linking:** The basic concept of dynamic linking is similar to dynamic loading. In dynamic linking, "Stub" is included for each appropriate library routine reference. A stub is a small piece of code. When the stub is executed, it checks whether the needed routine is already in memory or not. If not available then the program loads the routine into memory.

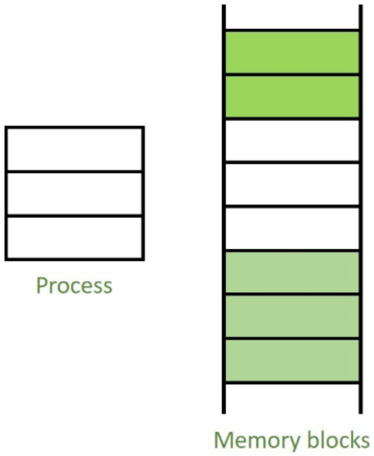
11.3.5 Swapping

When a process is executed it must have resided in memory. Swapping is a process of swap a process temporarily into a secondary memory from the main memory, which is fast as compared to secondary memory. A swapping allows more processes to be run and can be fit into memory at one time. The main part of swapping is transferred time and the total time directly proportional to the amount of memory swapped. Swapping is also known as roll-out, roll in, because if a higher priority process arrives and wants service, the memory manager can swap out the lower priority process and then load and execute the higher priority process. After finishing higher priority work, the lower priority process swapped back in memory and continued to the execution process.



11.3.6 Contiguous Memory Allocation

The main memory should oblige both the operating system and the different client processes. Therefore, the allocation of memory becomes an important task in the operating system. The memory is usually divided into two partitions: one for the resident operating system and one for the user processes. We normally need several user processes to reside in memory simultaneously. Therefore, we need to consider how to allocate available memory to the processes that are in the input queue waiting to be brought into memory. In adjacent memory allotment, each process is contained in a single contiguous segment of memory.



Contiguous Memory Allocation

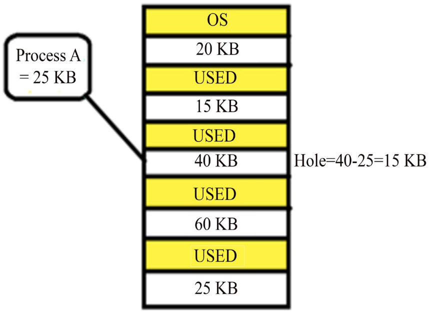
Memory allocation

To gain proper memory utilization, memory allocation must be allocated efficient manner. One of the simplest methods for allocating memory is to divide memory into several fixed-sized partitions and each partition contains exactly one process. Thus, the degree of multiprogramming is obtained by the number of partitions.

Multiple partition allocation: In this method, a process is selected from the input queue and loaded into the free partition. When the process terminates, the partition becomes available for other processes.

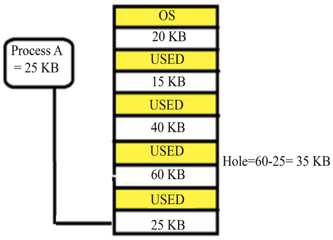
Fixed partition allocation: In this method, the operating system maintains a table that indicates which parts of memory are available and which are occupied by processes. Initially, all memory is available for user processes and is considered one large block of available memory. This available memory is known as "Hole". When the process arrives and needs memory, we search for a hole that is large enough to store this process. If the requirement fulfills then we allocate memory to process, otherwise keeping the rest available to satisfy future requests. While allocating a memory sometimes dynamic storage allocation problems occur, which concerns how to satisfy a request of size n from a list of free holes. There are some solutions to this problem:

- **First fit:-**In the first fit, the first available free hole fulfills the requirement of the process allocated.



Here, in this diagram 40 KB memory block is the first available free hole that can store process A (size of 25 KB), because the first two blocks did not have sufficient memory space.

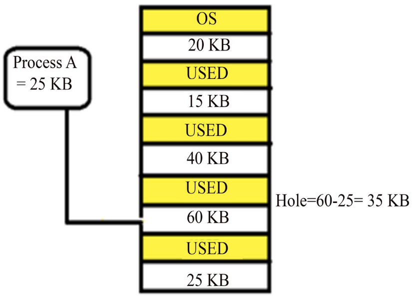
- **Best fit:-**In the best fit, allocate the smallest hole that is big enough to process requirements. For this, we search the entire list, unless the list is ordered by size.



Here in this example, first, we traverse the complete list and find the last hole 25KB is the best suitable hole for Process A(size 25KB).

In this method memory utilization is maximum as compared to other memory allocation techniques.

- **Worst fit:-**In the worst fit, allocate the largest available hole to process. This method produces the largest leftover hole.



Here in this example, Process A (Size 25 KB) is allocated to the largest available memory block which is 60KB. Inefficient **memory utilization** is a major issue in the worst fit.

Keyword

Memory utilization is the average utilization derived from the percent of available memory in use at a given moment.

11.3.7 Fragmentation

A Fragmentation is defined as when the process is loaded and removed after execution from memory, it creates a small free hole. These holes cannot be assigned to new processes because holes are not combined or do not fulfill the memory requirement of the process. To achieve a degree of multiprogramming, we must reduce the waste of memory or fragmentation problem. In operating system two types of fragmentation:

Internal fragmentation

Internal fragmentation occurs when memory blocks are allocated to the process more than their requested size. Due to this some unused space is leftover and creates an internal fragmentation problem.

Example: Suppose there is a fixed partitioning is used for memory allocation and the different size of block 3MB, 6MB, and 7MB space in memory. Now a new process p4 of size 2MB comes and demand for the block of memory. It gets a memory block of 3MB but 1MB block memory is a waste, and it cannot be allocated to other processes too. This is called internal fragmentation.

External fragmentation:

In external fragmentation, we have a free memory block, but we cannot assign it to process because blocks are not contiguous.

Example: Suppose (consider above example) three process p1, p2, p3 comes with size 2MB, 4MB, and 7MB respectively. Now they get memory blocks of size 3MB, 6MB, and 7MB allocated respectively. After allocating process p1 process and p2 process left 1MB and 2MB. Suppose a new process p4 comes and demands a 3MB block of memory, which is available, but we cannot assign it because free memory space is not contiguous. This is called external fragmentation.

Both the first fit and best-fit systems for memory allocation affected by external fragmentation. To overcome the external fragmentation problem Compaction is used. In the compaction technique, all free memory space combines and makes one large block. So, this space can be used by other processes effectively.

Another possible solution to the external fragmentation is to allow the logical address space of the processes to be noncontiguous, thus permit a process to be allocated physical memory where ever the latter is available.

11.3.8 Paging

Paging is a memory management scheme that eliminates the need for contiguous allocation of physical memory. This scheme permits the physical address space of a process to be non-contiguous.

- Logical Address or Virtual Address (represented in bits): An address generated by the CPU
- Logical Address Space or Virtual Address Space (represented in words or bytes): The set of all logical addresses generated by a program
- Physical Address (represented in bits): An address actually available on a memory unit
- Physical Address Space (represented in words or bytes): The set of all physical addresses corresponding to the logical addresses

Example:

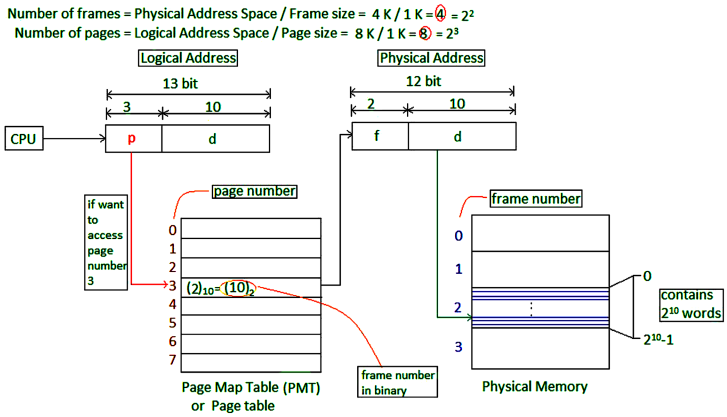
- If Logical Address = 31 bits, then Logical Address Space = 2^{31} words = 2 G words (1 G = 2^{30})
- If Logical Address Space = 128 M words = $2^7 * 2^{20}$ words, then Logical Address = $\log_2 2^{27}$ = 27 bits
- If Physical Address = 22 bits, then Physical Address Space = 2^{22} words = 4 M words (1 M = 2^{20})
- If Physical Address Space = 16 M words = $2^4 * 2^{20}$ words, then Physical Address = $\log_2 2^{24}$ = 24 bits

The mapping from virtual to physical address is done by the memory management unit (MMU) which is a hardware device and this mapping is known as the paging technique.

- The Physical Address Space is conceptually divided into several fixed-size blocks, called frames.
- The Logical Address Space is also split into fixed-size blocks, called pages.
- Page Size = Frame Size

Let us consider an example:

- Physical Address = 12 bits, then Physical Address Space = 4 K words
- Logical Address = 13 bits, then Logical Address Space = 8 K words
- Page size = frame size = 1 K words (assumption)



The address generated by the CPU is divided into

- **Page number(p):** Number of bits required to represent the pages in Logical Address Space or Page number
- **Page offset (d):** Number of bits required to represent a particular word in a page or page size of Logical Address Space or word number of a page or page offset.

Physical Address is divided into

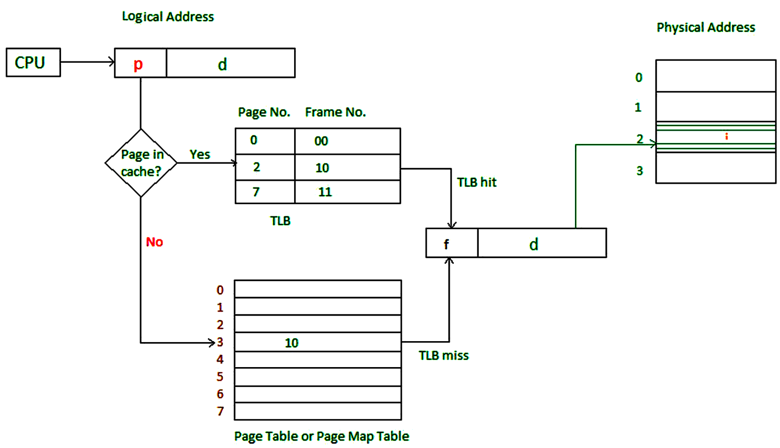
- **Frame number(f):** Number of bits required to represent the frame of Physical Address Space or Frame number frame
- **Frame offset (d):** Number of bits required to represent a particular word in a frame or frame size of Physical Address Space or word number of a frame or frame offset.

The hardware implementation of the page table can be done by using dedicated registers. But the usage of register for the page table is satisfactory only if the page table is small. If the page table contains a large number of entries then we can use TLB (**translation Look-aside buffer**), a special, small, fast look-up hardware cache.

Keyword

Translation look-aside buffer (TLB) is a memory cache that is used to reduce the time taken to access a user memory location. It is a part of the chip's memory-management unit (MMU).

- The TLB is an associative, high-speed memory.
- Each entry in TLB consists of two parts: a tag and a value.
- When this memory is used, then an item is compared with all tags simultaneously. If the item is found, then the corresponding value is returned.



Main memory access time = m

If page table are kept in main memory,

Effective access time = m(for page table) + m(for particular page in page table)

11.4 IMPLEMENTATION OF ALL PARTITION ALLOCATION METHODS IN MEMORY MANAGEMENT

In Partition Allocation, when there is more than one partition freely available to accommodate a process request, a partition must be selected. To choose a particular partition, a partition allocation method is needed. A partition allocation method is considered better if it avoids internal fragmentation.

Consider the following data for process:

Process No.	Process Size
1	88
2	192
3	277
4	365
5	489

Consider the following data for memory slots:

Memory Block No.	Memory Block Size
1	400
2	500
3	300
4	200
5	100

Below are the various partition allocation schemes with their implementation with respect to the given data above.

REMEMBER

First Fit Algorithm is the simplest technique of allocating the memory block to the processes amongst all. In this algorithm, the pointer keeps track of all the free blocks in the memory and accepts the request of allocating a memory block to the coming process.

11.4.1 First Fit

This method keeps the free/busy list of jobs organized by memory location, low-ordered to high-ordered memory. In this method, the first job claims the first available memory with space more than or equal to its size. The operating system doesn't search for appropriate partition but just allocate the job to the nearest memory partition available with sufficient size.

Below is the implementation of the First Fit Algorithm:

```
// C++ program for the implementation
// of the First Fit algorithm
#include <iostream>
#include <queue>
#include <vector>
using namespace std;

// Process Class
class process {
public:
    // Size & number of process
    size_t size;
```

```
    pid_t no;
};

// Memory Class
class memory {
public:
    size_t size;

    // Number of memory & queue of space
    // occupied by process
    pid_t no;
    queue<process> space_occupied;

    // Function to push process in a block
    void push(const process p)
    {
        if (p.size <= size) {
            space_occupied.push(p);
            size -= p.size;
        }
    }

    // Function to pop and return the
    // process from the block
    process pop()
    {
        process p;
```

```
        // If space occupied is empty
        if (!space_occupied.empty()) {
            p = space_occupied.front();
            space_occupied.pop();
            size += p.size;
            return p;
        }
    }

    // Function to check if block is
    // completely empty
    bool empty()
    {
        return space_occupied.empty();
    }
};

// Function to get data of processess
// allocated using first fit
vector<memory> first_fit(vector<memory> memory_blocks,
                         queue<process> processess)
{
    int i = 0;
    bool done, done1;
    memory na;
    na.no = -10;
```

```
    while (!processess.empty()) {
        done = 0;
        for (i = 0; i < memory_blocks.size(); i++) {
            done1 = 0;
            if (memory_blocks.at(i).size
                >= processess.front().size) {
                memory_blocks.at(i).push(processess.front());
                done = 1;
                done1 = 1;
                break;
            }
        }

        // If process is done
        if (done == 0 && done1 == 0) {
            na.size += processess.front().size;
            na.push(processess.front());
        }

        // pop the process
        processess.pop();
    }
    if (!na.space_occupied.empty())
        memory_blocks.push_back(na);
    return memory_blocks;
}
```

```
// Function to display the allocation
// of all processess
void display(vector<memory> memory_blocks)
{
    int i = 0, temp = 0;
    process p;
    cout << "+-------------+--------------+--------------+"
         << endl;
    cout << "| Process no. | Process size | Memory block |"
         << endl;
    cout << "+-------------+--------------+--------------+"
         << endl;

    // Traverse memory blocks size
    for (i = 0; i < memory_blocks.size(); i++) {

        // While memory block size is not empty
        while (!memory_blocks.at(i).empty()) {
            p = memory_blocks.at(i).pop();
            temp = to_string(p.no).length();
            cout << "|" << string(7 - temp / 2 - temp % 2, ' ')
                 << p.no << string(6 - temp / 2, ‹ ‹)
                 << «|»;

            temp = to_string(p.size).length();
            cout << string(7 - temp / 2 - temp % 2, ' ')
                 << p.size
```

```
            << string(7 - temp / 2, ‹ ‹) << «|»;

        temp = to_string(memory_blocks.at(i).no).length();
        cout << string(7 - temp / 2 - temp % 2, ‘ ‘);

        // If memory blocks is assigned
        if (memory_blocks.at(i).no != -10) {
            cout << memory_blocks.at(i).no;
        }

        // Else memory blocks is assigned
        else {
            cout << “N/A”;
        }
        cout << string(7 - temp / 2, ‘ ‘)
            << «|» << endl;
    }
  }
  cout << “+-------------+--------------+--------------+”
      << endl;
}

// Driver Code
int main()
{
  // Declare memory blocks
  vector<memory> memory_blocks(5);
```

```
// Declare first fit blocks
vector<memory> first_fit_blocks;

// Declare queue of all processess
queue<process> processess;
process temp;

// Set sample data
memory_blocks[0].no = 1;
memory_blocks[0].size = 400;

memory_blocks[1].no = 2;
memory_blocks[1].size = 500;

memory_blocks[2].no = 3;
memory_blocks[2].size = 300;

memory_blocks[3].no = 4;
memory_blocks[3].size = 200;

memory_blocks[4].no = 5;
memory_blocks[4].size = 100;

temp.no = 1;
temp.size = 88;
```

```
// Push the process
processess.push(temp);

temp.no = 2;
temp.size = 192;

// Push the process
processess.push(temp);

temp.no = 3;
temp.size = 277;

// Push the process
processess.push(temp);

temp.no = 4;
temp.size = 365;

// Push the process
processess.push(temp);

temp.no = 5;
temp.size = 489;

// Push the process
processess.push(temp);
```

```
    // Get the data
    first_fit_blocks = first_fit(memory_blocks, processess);

    // Display the data
    display(first_fit_blocks);
    memory_blocks.clear();
    memory_blocks.shrink_to_fit();
    first_fit_blocks.clear();
    first_fit_blocks.shrink_to_fit();
    return 0;
}
```

Output:

```
+-------------+--------------+--------------+
| Process no. | Process size | Memory block |
+-------------+--------------+--------------+
|      1      |      88      |       1      |
|      2      |     192      |       1      |
|      3      |     277      |       2      |
|      4      |     365      |     N/A      |
|      5      |     489      |     N/A      |
+-------------+--------------+--------------+
```

11.4.2 Next Fit

The next fit is a modified version of 'first fit'. It begins as the first fit to find a free partition but when called next time it starts searching from where it left off, not from the beginning. This policy makes use of a roving pointer. The pointer moves along the memory chain to search for a next fit. This helps in, to avoid the usage of memory always from the head (beginning) of the free block chain.

Below is the implementation of the Next Fit Algorithm:

```
// C++ program for the implementation
// of the Next Fit algorithm
#include <iostream>
#include <queue>
#include <vector>
using namespace std;

// Process Class
class process {
public:
    // Size & number of process
    size_t size;
    pid_t no;
};

// Memory Class
class memory {
public:
    size_t size;

    // Number of memory & queue of space
    // occupied by process
    pid_t no;
    queue<process> space_occupied;

    // Function to push process in a block
```

DID YOU KNOW ?

Next fit is another version of First Fit in which memory is searched for empty spaces similar to the first fit memory allocation scheme. Unlike first-fit memory allocation, the only difference between the two is, in the case of next fit, if the search is interrupted in between, the new search is carried out from the last location.

```
void push(const process p)
{
    if (p.size <= size) {
        space_occupied.push(p);
        size -= p.size;
    }
}

// Function to pop and return the
// process from the block
process pop()
{
    process p;

    // If space occupied is empty
    if (!space_occupied.empty()) {
        p = space_occupied.front();
        space_occupied.pop();
        size += p.size;
        return p;
    }
}

// Function to check if block is
// completely empty
bool empty()
{
```

```
        return space_occupied.empty();
    }
};

// Function to get data of processess
// allocated using Next Fit
vector<memory> next_fit(vector<memory> memory_blocks,
                        queue<process> processess)
{
    int i = 0;
    bool done, done1;
    memory na;
    na.no = -10;

    // Loop till process is empty
    while (!processess.empty()) {
        done1 = 0;

        // Traverse memory_blocks
        for (i = 0; i < memory_blocks.size(); i++) {
            done = 0;

            // If process is not empty
         if (!processess.empty() && memory_blocks.at(i).size >= processess.front().size) {
                memory_blocks.at(i).push(processess.front());
                done = 1;
                done1 = 1;
```

```
                processess.pop();
            }
        }
        if (!processess.empty() && done == 0 && done1 == 0) {
            na.size += processess.front().size;
            na.push(processess.front());
            processess.pop();
        }
    }

    // If space is not occupied push
    // the memory_blocks na
    if (!na.space_occupied.empty()) {
        memory_blocks.push_back(na);
    }

    return memory_blocks;
}

// Function to display the allocation
// of all processess
void display(vector<memory> memory_blocks)
{
    int i = 0, temp = 0;
    process p;
    cout << "+-------------+--------------+--------------+"
         << endl;
```

```
cout << "| Process no. | Process size | Memory block |"
      << endl;
cout << "+-------------+--------------+--------------+"
      << endl;

// Traverse memory blocks size
for (i = 0; i < memory_blocks.size(); i++) {

     // While memory block size is not empty
     while (!memory_blocks.at(i).empty()) {
          p = memory_blocks.at(i).pop();
          temp = to_string(p.no).length();
          cout << "|" << string(7 - temp / 2 - temp % 2, ' ')
                << p.no << string(6 - temp / 2, ‹ ‹)
                << «|»;

          temp = to_string(p.size).length();
          cout << string(7 - temp / 2 - temp % 2, ' ')
                << p.size
                << string(7 - temp / 2, ‹ ‹) << «|»;

          temp = to_string(memory_blocks.at(i).no).length();
          cout << string(7 - temp / 2 - temp % 2, ' ');

          // If memory blocks is assigned
          if (memory_blocks.at(i).no != -10) {
               cout << memory_blocks.at(i).no;
```

```
        }

        // Else memory blocks is assigned
        else {
            cout << "N/A";
        }
        cout << string(7 - temp / 2, ' ')
             << «|» << endl;
    }
  }
  cout << "+-------------+--------------+--------------+"
       << endl;
}

// Driver Code
int main()
{
  // Declare memory blocks
  vector<memory> memory_blocks(5);

  // Declare next fit blocks
  vector<memory> next_fit_blocks;

  // Declare queue of all processess
  queue<process> processess;
  process temp;
```

```
// Set sample data
memory_blocks[0].no = 1;
memory_blocks[0].size = 400;

memory_blocks[1].no = 2;
memory_blocks[1].size = 500;

memory_blocks[2].no = 3;
memory_blocks[2].size = 300;

memory_blocks[3].no = 4;
memory_blocks[3].size = 200;

memory_blocks[4].no = 5;
memory_blocks[4].size = 100;

temp.no = 1;
temp.size = 88;

// Push the process
processess.push(temp);
temp.no = 2;
temp.size = 192;

// Push the process
processess.push(temp);
temp.no = 3;
```

```
    temp.size = 277;

    // Push the process
    processess.push(temp);
    temp.no = 4;
    temp.size = 365;

    // Push the process
    processess.push(temp);
    temp.no = 5;
    temp.size = 489;

    // Push the process
    processess.push(temp);

    // Get the data
    next_fit_blocks = next_fit(memory_blocks,
                               processess);

    // Display the data
    display(next_fit_blocks);
    memory_blocks.clear();
    memory_blocks.shrink_to_fit();
    next_fit_blocks.clear();
    next_fit_blocks.shrink_to_fit();
    return 0;
}
```

Output:

```
+-------------+--------------+--------------+
| Process no. | Process size | Memory block |
+-------------+--------------+--------------+
|     1       |     88       |     1        |
|     2       |     192      |     2        |
|     3       |     277      |     3        |
|     4       |     365      |     N/A      |
|     5       |     489      |     N/A      |
+-------------+--------------+--------------+
```

REMEMBER

Worst Fit allocates a process to the partition which is largest sufficient among the freely available partitions available in the main memory. If a large process comes at a later stage, then memory will not have space to accommodate it.

11.4.3 Worst Fit

Worst Fit allocates a process to the partition which is largest sufficient among the freely available partitions available in the main memory. If a large process comes at a later stage, then memory will not have space to accommodate it.

Below is the implementation of the Worst Fit Algorithm:

```
// C++ program for the implementation
// of the Worst Fit algorithm
#include <iostream>
#include <queue>
#include <vector>
using namespace std;

// Process Class
class process {
public:
```

```
    // Size & number of process
    size_t size;
    pid_t no;
};

// Memory Class
class memory {
public:
    size_t size;

    // Number of memory & queue of space
    // occupied by process
    pid_t no;
    queue<process> space_occupied;

    // Function to push process in a block
    void push(const process p)
    {
        if (p.size <= size) {
            space_occupied.push(p);
            size -= p.size;
        }
    }

    // Function to pop and return the
    // process from the block
    process pop()
```

```
    {
        process p;

        // If space occupied is empty
        if (!space_occupied.empty()) {
            p = space_occupied.front();
            space_occupied.pop();
            size += p.size;
            return p;
        }
    }

    // Function to check if block is
    // completely empty
    bool empty()
    {
        return space_occupied.empty();
    }
};

// Function to get data of processess
// allocated using Worst Fit
vector<memory> worst_fit(vector<memory> memory_blocks,
                         queue<process> processess)
{
    int i = 0, index = 0, max;
    memory na;
```

```
na.no = -10;

// Loop till process queue is not empty
while (!processess.empty()) {
    max = 0;

    // Traverse the memory_blocks
    for (i = 0; i < memory_blocks.size(); i++) {
        if (memory_blocks.at(i).size >= processess.front().size
            && memory_blocks.at(i).size > max) {
            max = memory_blocks.at(i).size;
            index = i;
        }
    }
    if (max != 0) {
        memory_blocks.at(index).push(processess.front());
    }

    else {
        na.size += processess.front().size;
        na.push(processess.front());
    }

    // Pop the current process
    processess.pop();
}
```

```
    // If space is not occupied
    if (!na.space_occupied.empty()) {
        memory_blocks.push_back(na);
    }

    // Return the memory
    return memory_blocks;
}

// Function to display the allocation
// of all processess
void display(vector<memory> memory_blocks)
{
    int i = 0, temp = 0;
    process p;
    cout << "+-------------+--------------+--------------+"
         << endl;
    cout << "| Process no. | Process size | Memory block |"
         << endl;
    cout << "+-------------+--------------+--------------+"
         << endl;

    // Traverse memory blocks size
    for (i = 0; i < memory_blocks.size(); i++) {

        // While memory block size is not empty
        while (!memory_blocks.at(i).empty()) {
```

```
        p = memory_blocks.at(i).pop();
        temp = to_string(p.no).length();
        cout << "|" << string(7 - temp / 2 - temp % 2, ' ')
            << p.no << string(6 - temp / 2, ‹ ‹)
            << «|»;

        temp = to_string(p.size).length();
        cout << string(7 - temp / 2 - temp % 2, ' ')
            << p.size
            << string(7 - temp / 2, ‹ ‹) << «|»;

        temp = to_string(memory_blocks.at(i).no).length();
        cout << string(7 - temp / 2 - temp % 2, ' ');

        // If memory blocks is assigned
        if (memory_blocks.at(i).no != -10) {
            cout << memory_blocks.at(i).no;
        }

        // Else memory blocks is assigned
        else {
            cout << "N/A";
        }
        cout << string(7 - temp / 2, ' ')
            << «|» << endl;
    }
}
```

```
    cout << "+-------------+--------------+--------------+"
         << endl;
}

// Driver Code
int main()
{
    // Declare memory blocks

    vector<memory> memory_blocks(5);

    // Declare worst fit blocks
    vector<memory> worst_fit_blocks;

    // Declare queue of all processess
    queue<process> processess;
    process temp;

    // Set sample data
    memory_blocks[0].no = 1;
    memory_blocks[0].size = 400;

    memory_blocks[1].no = 2;
    memory_blocks[1].size = 500;

    memory_blocks[2].no = 3;
    memory_blocks[2].size = 300;
```

```
memory_blocks[3].no = 4;
memory_blocks[3].size = 200;

memory_blocks[4].no = 5;
memory_blocks[4].size = 100;

temp.no = 1;
temp.size = 88;

// Push the process
processess.push(temp);
temp.no = 2;
temp.size = 192;

// Push the process
processess.push(temp);
temp.no = 3;
temp.size = 277;

// Push the process
processess.push(temp);
temp.no = 4;
temp.size = 365;

// Push the process
processess.push(temp);
```

```
    temp.no = 5;
    temp.size = 489;

    // Push the process
    processess.push(temp);

    // Get the data
    worst_fit_blocks = worst_fit(memory_blocks,
                                 processess);

    // Display the data
    display(worst_fit_blocks);
    memory_blocks.clear();
    memory_blocks.shrink_to_fit();
    worst_fit_blocks.clear();
    worst_fit_blocks.shrink_to_fit();
    return 0;
}
```

Output:

```
+-------------+-------------+-------------+
| Process no. | Process size | Memory block |
+-------------+-------------+-------------+
|      3      |     277     |      1      |
|      1      |      88     |      2      |
|      2      |     192     |      2      |
|      4      |     365     |     N/A     |
|      5      |     489     |     N/A     |
+-------------+-------------+-------------+
```

11.4.4 Best Fit

This method keeps the free/busy list in order by size – smallest to largest. In this method, the operating system first searches the whole of the memory according to the size of the given job and allocates it to the closest-fitting free partition in the memory, making it able to use memory efficiently. Here the jobs are in the order from smallest job to the largest job.

Below is the implementation of the Best Fit Algorithm:

```
// C++ program for the implementation
// of the Best Fit algorithm
#include <iostream>
#include <queue>
#include <vector>
using namespace std;

// Process Class
class process {
public:
    // Size & number of process
    size_t size;
    pid_t no;
};

// Memory Class
class memory {
public:
    size_t size;
```

REMEMBER

In best fit method, the operating system first searches the whole of the memory according to the size of the given job and allocates it to the closest-fitting free partition in the memory, making it able to use memory efficiently. Here the jobs are in the order from smallest job to largest job.

```
// Number of memory & queue of space
// occupied by process
pid_t no;
queue<process> space_occupied;

// Function to push process in a block
void push(const process p)
{
    if (p.size <= size) {
        space_occupied.push(p);
        size -= p.size;
    }
}

// Function to pop and return the
// process from the block
process pop()
{
    process p;

    // If space occupied is empty
    if (!space_occupied.empty()) {
        p = space_occupied.front();
        space_occupied.pop();
        size += p.size;
        return p;
    }
```

```
    }

    // Function to check if block is
    // completely empty
    bool empty()
    {
        return space_occupied.empty();
    }
};

// Function to get data of processess
// allocated using Best Fit
vector<memory> best_fit(vector<memory> memory_blocks,
                        queue<process> processess)
{
    int i = 0, min, index = 0;
    memory na;
    na.no = -10;

    // Loop till processe is not empty
    while (!processess.empty()) {
        min = 0;

        // Traverse the memory_blocks
        for (i = 0; i < memory_blocks.size(); i++) {
            if (memory_blocks.at(i).size >= processess.front().size && (min == 0 ||
memory_blocks.at(i).size < min)) {
```

```
                min = memory_blocks.at(i).size;
                index = i;
            }
        }

        if (min != 0) {
            memory_blocks.at(index).push(processess.front());
        }
        else {
            na.size += processess.front().size;
            na.push(processess.front());
        }

        // Pop the processe
        processess.pop();
    }

    // If space is no occupied then push
    // the current memory na
    if (!na.space_occupied.empty()) {
        memory_blocks.push_back(na);
    }

    // Return the memory_blocks
    return memory_blocks;
}
```

```
// Function to display the allocation
// of all processess
void display(vector<memory> memory_blocks)
{
    int i = 0, temp = 0;
    process p;
    cout << "+-------------+--------------+--------------+"
        << endl;
    cout << "| Process no. | Process size | Memory block |"
        << endl;
    cout << "+-------------+--------------+--------------+"
        << endl;

    // Traverse memory blocks size
    for (i = 0; i < memory_blocks.size(); i++) {

        // While memory block size is not empty
        while (!memory_blocks.at(i).empty()) {
            p = memory_blocks.at(i).pop();
            temp = to_string(p.no).length();
            cout << "|" << string(7 - temp / 2 - temp % 2, ' ')
                << p.no << string(6 - temp / 2, ‹ ‹)
                << «|»;

            temp = to_string(p.size).length();
            cout << string(7 - temp / 2 - temp % 2, ' ')
                << p.size
```

```
            << string(7 - temp / 2, ‹ ‹) << «|»;

        temp = to_string(memory_blocks.at(i).no).length();
        cout << string(7 - temp / 2 - temp % 2, ‘ ‘);

        // If memory blocks is assigned
        if (memory_blocks.at(i).no != -10) {
            cout << memory_blocks.at(i).no;
        }

        // Else memory blocks is assigned
        else {
            cout << “N/A”;
        }
        cout << string(7 - temp / 2, ‘ ‘)
            << «|» << endl;
    }
  }
  cout << “+-------------+--------------+--------------+”
       << endl;
}

// Driver Code
int main()
{
  // Declare memory blocks
  vector<memory> memory_blocks(5);
```

```
// Declare best fit blocks
vector<memory> best_fit_blocks;

// Declare queue of all processess
queue<process> processess;
process temp;

// Set sample data
memory_blocks[0].no = 1;
memory_blocks[0].size = 400;

memory_blocks[1].no = 2;
memory_blocks[1].size = 500;

memory_blocks[2].no = 3;
memory_blocks[2].size = 300;

memory_blocks[3].no = 4;
memory_blocks[3].size = 200;

memory_blocks[4].no = 5;
memory_blocks[4].size = 100;

temp.no = 1;
temp.size = 88;
```

```
// Push the processe to queue
processess.push(temp);
temp.no = 2;
temp.size = 192;

// Push the processe to queue
processess.push(temp);
temp.no = 3;
temp.size = 277;

// Push the processe to queue
processess.push(temp);
temp.no = 4;
temp.size = 365;

// Push the processe to queue
processess.push(temp);
temp.no = 5;
temp.size = 489;

// Push the processe to queue
processess.push(temp);

// Get the data
best_fit_blocks = best_fit(memory_blocks,
                           processess);
```

```
    // Display the data
    display(best_fit_blocks);
    memory_blocks.clear();
    memory_blocks.shrink_to_fit();
    best_fit_blocks.clear();
    best_fit_blocks.shrink_to_fit();
    return 0;
}
```

Output:

```
+-------------+--------------+--------------+
| Process no. | Process size | Memory block |
+-------------+--------------+--------------+
|      4      |     365      |      1       |
|      5      |     489      |      2       |
|      3      |     277      |      3       |
|      2      |     192      |      4       |
|      1      |      88      |      5       |
+-------------+--------------+--------------+
```

SUMMARY

- Memory management is the process of controlling and coordinating computer memory, assigning portions called blocks to various running programs to optimize overall system performance. Memory management resides in hardware, in the OS (operating system), and in programs and applications.
- Memory Management is the process of controlling and coordinating computer memory, assigning portions known as blocks to various running programs to optimize the overall performance of the system.
- Memory management is a form of resource management applied to computer memory. The essential requirement of memory management is to provide ways to dynamically allocate portions of memory to programs at their request, and free it for reuse when no longer needed.
- Memory protection is a phenomenon by which we control memory access rights on a computer. The main aim of it is to prevent a process from accessing memory that has not been allocated to it.
- Fragmentation occurs in a dynamic memory allocation system when most of the free blocks are too small to satisfy any request. It is generally termed as the inability to use the available memory.
- A Page Table is the data structure used by a virtual memory system in a computer operating system to store the mapping between the virtual address and physical addresses.
- Segmentation allows the breaking of the virtual address space of a single process into segments that may be placed in non-contiguous areas of physical memory.
- Memory management is one of the more complex parts of system troubleshooting, as it involves a certain degree of guesswork and estimation. Still, you can achieve good results by monitoring the tunables and adjusting them to match your scenario.
- SFC Scanner is a Microsoft tool for detecting various problems with your system, and running it seems to have solved some people's memory management woes.
- Software problems are a little more challenging to pin down. Still, if the memory management error is a relatively new phenomenon, you could try undoing some of your recent software installations to see if it fixes the problem.
- The main memory is central to the operation of a modern computer. Main Memory is a large array of words or bytes, ranging in size from hundreds of thousands to billions.
- Logical Address space: An address generated by the CPU is known as "Logical Address". It is also known as a Virtual address. Logical address space can be defined as the size of the process. A logical address can be changed.

KNOWLEDGE CHECK

1. **CPU fetches the instruction from memory according to the value of ____________**
   a. program counter
   b. status register
   c. instruction register
   d. program status word
2. **A memory buffer used to accommodate a speed differential is called ____________**
   a. stack pointer
   b. cache
   c. accumulator
   d. disk buffer
3. **Which one of the following is the address generated by CPU?**
   a. physical address
   b. absolute address
   c. logical address
   d. none of the mentioned
4. **Run time mapping from virtual to physical address is done by ____________**
   a. Memory management unit
   b. CPU
   c. PCI
   d. None of the mentioned
5. **Memory management technique in which system stores and retrieves data from secondary storage for use in main memory is called?**
   a. fragmentation
   b. paging
   c. mapping
   d.none of the mentioned
6. **The address of a page table in memory is pointed by ____________**
   a. stack pointer
   b. page table base register
   c. page register
   d. program counter

7. Program always deals with ____________

a. logical address

b. absolute address

c. physical address

d. relative address

8. The page table contains ____________

a. base address of each page in physical memory

b. page offset

c. page size

d. none of the mentioned

REVIEW QUESTIONS

1. What are the memory management techniques?
2. Which types of parameters used in memory management?
3. How to run windows memory diagnostic?
4. How to update your graphics card drivers?
5. Give an overview on contiguous memory allocation.

Check Your Results

1. (a)	2. (b)	3. (c)	4. (a)
5. (b)	6. (b)	7. (a)	8. (a)

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Level: Beginner to Advanced
Subject: Computer and Information Science

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3rd Edition

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